AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 17, NO. 35 WEEKLY. | NEW YORK, THURSDAY, AUGUST 30, 1894. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

COPYRIGHT 1894, BY AMERICAN MACHINIST PUBLISHING COMPANY. **For Sale Everywhere by Newsdealers.** ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Machine Shop Milling Practice.—XII.

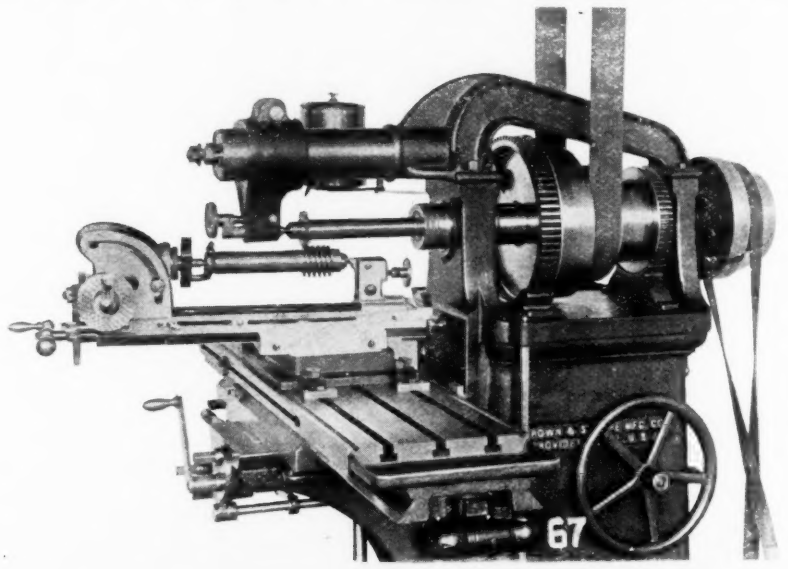
By Horace L Arnold

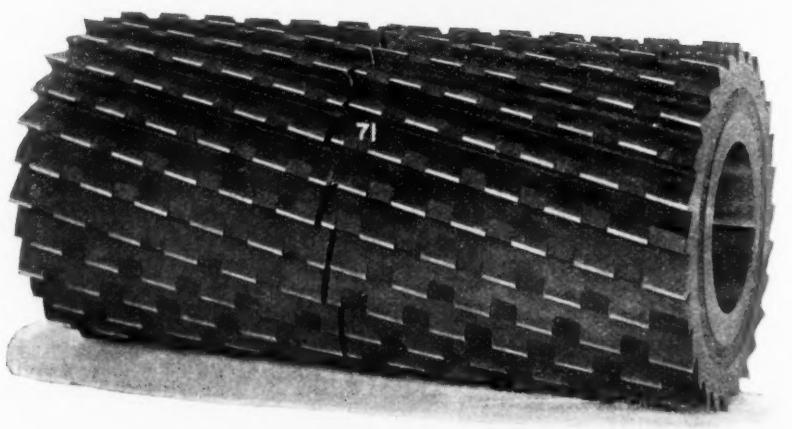
Lathe hands who have to cut quick pitch worms and screws in the lathe know very well the difficulties attending that operation, which, in the case of a quick pitch and multiple thread, is both planing and lathe work, and a very nice job of engine dividing besides, and calls for all the skill and patience the workman has, as well as a special lathe having a carriage drive capable of giving a carriage movement of as much velocity as the surface speed of the work and strong enough to make a planing head of the tool carriage. The lathe tool must also be shaped exactly to a correct template, and twisted to an angle of great inconvenience, making the whole job an anxious operation.

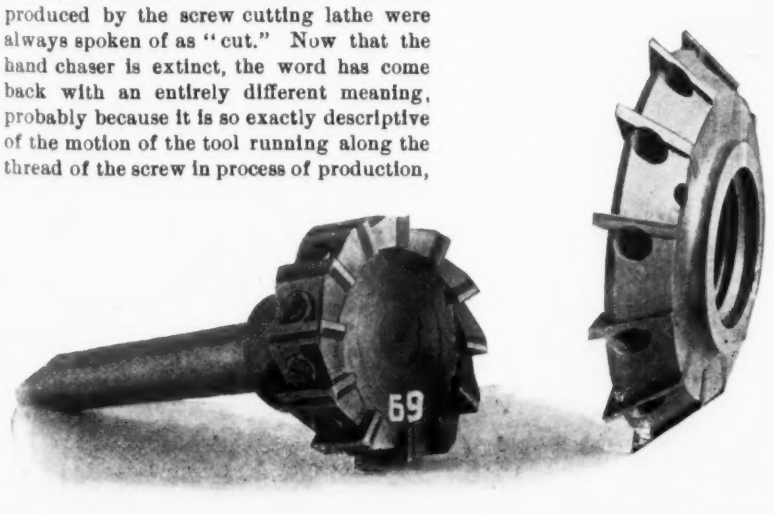
Fig. 67 shows how, by the use of the Brown & Sharpe index head set crosswise of the table of one of the large B. & S. milling machines, and a mill of the right shape, all this lathe worry is changed to a loafing job for a boy. The whole arrangement is so clearly shown in the reproduction of the photograph that nothing need be added in words except, perhaps, to say that there is no fixed relation between the spindle revolution and the work revolution. The dividing head and slide screw take care of all that, and the quietly rotating mill takes the place of the plowing tool carriage of the lathe. Tool room hands who have a B. & S. index machine in their plant can remember this Fig. 67 to advantage when replacing worn out feed worms. It is of course needful to finish a milled worm with repeated cuts without changing anything, but the same is true where the worm is "chased," or cut in the lathe. I use the word "chased," as it seems to be coming into general use in shops where the "chaser" and "chased" threads are things entirely unknown. In the old days when screw-cutting lathes, now so much the rule that we think nothing of them, were proud exceptions, machinists never spoke of a "chased" thread as being produced otherwise than with a *hand* "chaser." Threads produced by the screw cutting lathe were always spoken of as "cut." Now that the hand chaser is extinct, the word has come back with an entirely different meaning, probably because it is so exactly descriptive of the motion of the tool running along the thread of the screw in process of production, or because *fixed* "chasers" or multiple pointed threading tools fixed in the tool carriages of screw cutting machines are so generally used. I have always objected to the use of the word "chased" as descriptive of engine lathe cut screw threads, but it has evidently come back to stay, and I hear it so constantly that I feel constrained to accept it. And the only *good* way to "chase" quick pitch worms is to use the "chaser" teeth in a circle instead of in a straight line, round instead of flat, a rotating mill instead of a tool in the tool post twisted out of all reasonable shape and costing dollars if anything goes wrong with its edge.

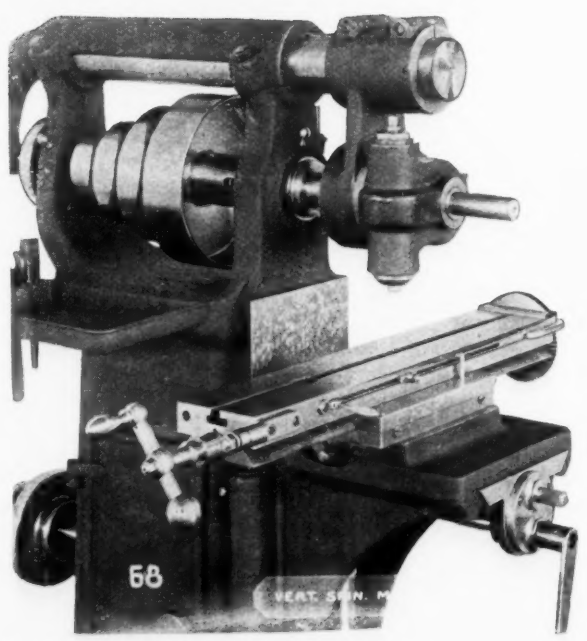
Although widely known, the B. & S. vertical spindle attachment shown in Fig. 68 must be mentioned here for the sake of completeness. As shown in Fig. 68, the vertical spindle is applied to the index machine, is driven by spiral gears, and is mounted on a graduated flange which aids in ready adjustment of the "vertical" spindle to any required angle from vertical to horizontal. For the Nos. 4 and 5 plain milling machines the vertical spindle is a heavier construction driven in substantially the same manner, but with bevel instead of spiral gearing. On the "No. 24" the vertical spindle holder is secured to the overhanging arm only; the spindle drive is a worm gear on the spindle driven by a worm belted from the machine cone. This leaves the main spindle of the machine free, so that, in some cases, both of the spindles are used at once, with a cutter in each. The "vertical," or rather "universal," spindle is of very great use for a multitude of operations not conveniently performed by mills in the main or fixed spindle of the machine. As will be shown later, machines having vertical spindles *only* stand well toward the front for convenience and economical effect, and the addition of a vertical spindle to the horizontal spindle machines gives them a feature of great value, in addition to their original excellence. At first sight it would seem an awkward job to add a spindle at right angles to the regular machine spindle, but Fig. 68 shows that, given a designer of sufficient ability, the job can be brought out in a form at once convenient and symmetrical.

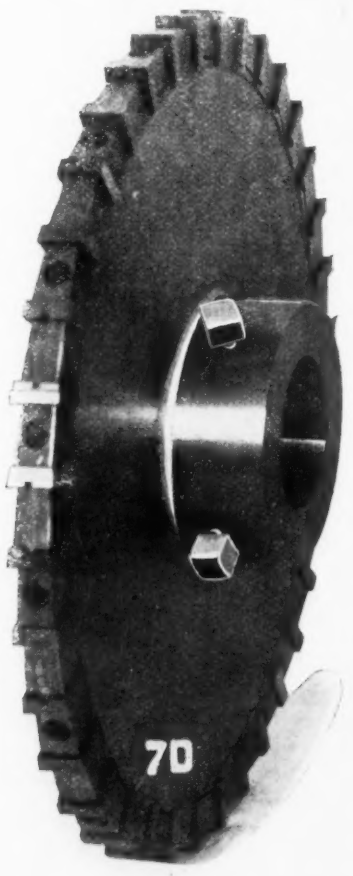
Fig. 69 shows the inserted mill tooth used by Brown & Sharpe. Each inserted tooth is held by a screw which stands at a small angle to the tooth which it holds, and passes through a thimble seated in the counterbored screw hole, so located in relation to the front face of the cutter that the thimble may be slabbed off on one side with a taper cut and have the flat face thus produced on the thimble bear against the cutter face hard, when drawn down by the screw. In the cylindrical mill in Fig. 69, the cutter blank itself is cleared away at the following extremity, same as if the whole division were a solid tooth; in the











MACHINE SHOP MILLING PRACTICE.

bevel cutter the stock is left plain from the lathe. This cutter fastening is, of course, very cheap, being only a screw and thimble for each tooth, and is very easily manipulated, and has the great merit of convenience all round. Fig. 70 shows a construction with a groove in each tooth, and a mating rib milled in each tooth seat, so as to secure the narrow-faced teeth perfectly against the possibility of side motion in the cutter stock. Each cut in the stock is made as wide as the thickness of two teeth, plus the space between two teeth, so that each cut takes two teeth, one with a groove in its face, and one with a groove in its back. Between the two teeth is a loose block forced inward by a fillister head screw; this block is cut to fill the space between the cutters while clear of the stock below, and thus forms the keystone of a flat arch of three pieces, and makes pressure from the screw on this keystone block very effective in keeping the groove and tongue cutters in place. By this construction the teeth have grooves in the face of one, and in the back of the next one, alternately; this introduces the "cape" and "flat" chisel action into the cuts made by these mills, which only have one half as many screws as the other form for the same number of teeth. Although this mill is very novel in tooth seating, consideration shows it to be simple and cheap, and the tongues and grooves are certainly valuable features. The original of this photograph was, I think, about 10 inches diameter.

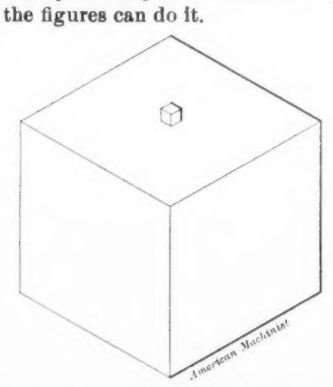
Most of the inserted tooth mills I noticed at the B. & S. shops were made like Fig. 69; comparatively few inserted tooth mills are used by them; the choice there seems to lean toward solid mills, of which a very fine example is shown in Fig. 71. This mill is, I think, about 6 inches diameter by 12 inches long, made in two pieces, and cut to lap at the joining. I do not find the memorandum of dimensions of this mill, but it was quite large. There seems to be no question whatever as to the value of the notched teeth. I have recently seen the output of the milling department in a shop of some size, materially improved both in quantity and quality by cutting the mill teeth, as in Fig. 71. The benefits in this case were very marked, as many of the milling machines were old and light, and the result of notching the teeth was to greatly improve the surface of the work produced, especially on steel; previous bad chatter marks entirely disappearing when the mill teeth were notched.

The Thermal Relations of Air and Water.

By Frank Richards

Only that I have loaned my kodak—the most valuable use that I have found for it—to a summer tourist friend, I would have liked to have placed at the head of this article a picture of a big dry-goods box with a tumbler of water upon it, as a handy and suggestive representation of the thermal relations of air and water. If we cannot have the visible picture, we can at least fix it in our mind's eye, and the application and the aptness of the proposed illustration may appear as we go along.

Say that we apply a given quantity or unit of heat to a pound of water, raising its temperature one degree, how much air would be equally heated one degree, by the same unit of heat? A cubic foot of air at atmospheric pressure, "free air," and at 62 degrees, weighs .076 pounds, and a pound of air therefore equals 13.158 cubic feet. A pound of water is 27.7 cubic inches, and the ratio of volumes of equal weight will be about 1 : 821. But, pound for pound, it takes less heat to raise the temperature of air one degree, or any number of degrees, than is required to raise the temperature of water the same number of degrees. The specific heat of water being 1, that of air is only .2377, so that 13.158 cubic feet ÷ .2377 = 55 cubic feet, and this 55 cubic feet of air is to be compared with 1 pound, or 27.7 cubic inches of water. A common sized glass tumbler, not quite full, holds a half pound of water. A cubical box measuring 3 feet each way, or a large dry-goods box, holds, of course, a cubic yard, or 27 cubic feet, which is, nearly enough, a half of our 55 cubic feet, so that the dry-goods box full of air, and the tumbler full of water, represent quite closely the volumes of air and of water that will be equally heated by equal units of heat. The approximate ratio of volumes will be 1 : 3431, and the ratio of the sides of two cubes representing the two volumes will be 1 : 15 +. The isometric projection of the two cubes, here shown, may convey and impress the relations better than the figures can do it.



It is to be remembered that in the transmission of heat either to or from air or water, that is, whether heating or cooling them, or whether cooling or heating any bodies in thermal communication with them, the above ratios will prevail. Those whose attention is called for the first time to the phenomena accompanying air compression or expansion cannot fail to be struck with the great changes of temperature that accompany either operation, but the actual heat represented by these changes is usually overestimated, although suggestions that should check the exaggerated estimate are also at hand. If the air compressing cylinder and the cylinder heads are properly water jacketed, the temperature of the air delivered is considerably lower than it would be, if there were no water jacketing, but at the same time the perceptible heating of the water in the jacket by which the cooling is effected proceeds quite slowly, showing that the actual quantity of heat abstracted from the air by that means is not great. So when the heated compressed air flows through pipes for some distance the rapidity with which its temperature approaches that of its environment is another evidence of the small amount of heat actually carried. Still we hear constantly of the wonders of heating or cooling that are to be done by compressed air, wonders that never fully materialize with a more extended experience. In the Pohle "air lift pump," which is not properly a pump, as it has absolutely no moving or working or wearing parts, but which is a very valuable application of compressed air direct for raising water from bored wells, and where the air is discharged upward into the submerged end of a vertical pipe, the air entering the pipe, distributing itself among the water and rising with it, expanding as it rises, it is claimed that the expansion of the air, while in contact with the water, cools the water. We may say that the expanding air certainly does cool the water, and we may also say that it certainly does not cool it more than a fraction of a single degree. In a recent issue of the American Machinist I spoke of a means of cooling drinking water by compressed air by expanding the air into a long pipe enclosing a small water pipe within it. If any one having a supply of compressed air at hand has taken the pains to rig up this device, I expect to hear before long that it takes a great quantity of air to cool a little water, which is just about what I am writing at this moment. The case, however, in the matter of cooling by compressed air is not nearly as bad as I seem to make it appear. The actual heat represented by any change of temperature in compressed air is, of course, greater than for free air, and directly as its absolute pressure. With air at 75 pounds gauge, or 6 atmospheres, the same change of temperature would indicate six times the amount of heat that would be indicated by free air. Then the sudden release of air compressed to 6 atmospheres, and at 60 degrees, would mean a theoretical fall of temperature of over 200 degrees, and the water only required to be cooled 20 degrees, this would give the air considerable opportunity. In the case of the air-lift pump, mentioned above, where the volume of water would probably be as great as that of the compressed air in contact with it, the cooling effect would be but slight.

While the loss of heat in air has a comparatively small cooling effect upon whatever may be in contact with it, the fact when reversed is of advantage in the use of air for power transmission. It requires but little heat to raise the temperature of air, and, as is well known, in the reheating of compressed air and its consequent increase of volume, more power may be practically developed from the heat employed than in any other known mode of applying it. In the recent valuable report upon compressed air appliances by the committee of the Master Car Builders Association, they say, "It was reported by the manufacturers of air appliances that superheated compressed air used in air lifts, jacks, engines, etc., increases the efficiency fully 50 per cent., but your committee was unable to make tests or procure reliable data, etc." The matter of reheating or superheating compressed air where it is to be used slowly or intermittently, as in all direct hoisting, is not worth considering for a moment, as it is one thing, and an easy one, to heat the air, while it is a very different and difficult thing to keep it hot. It would be necessary to keep the pipe which conveyed the air constantly hot, and also the cylinder in which the air was used, or it would be cooled before it began to do its work. The heating of compressed air, except for continuously running engines may be said to be practically impossible, or at least that it would cost more than it would be worth.

Comparing compressed air at a given pressure, say, 75 pounds, gauge, with steam at the same pressure, we know that about 2 cubic feet of steam at that pressure are required under the best modern methods, to produce one cubic foot of compressed air at the same pressure. But with the volume of compressed air that results from the reheating of the air, these figures are more than reversed That is, having a certain volume of compressed air at normal temperature, and increasing that volume by heating the air, and taking the heat cost of the resulting additional volume of air and comparing it with the heat cost of steam at the same pressure, we find that in this case steam costs in heat about four times as much as the additional volume of air has cost in heat. The following crude figures will give a sufficiently accurate idea of the relative heat cost of steam and of superheated compressed air:

Weight of 1 cubic foot of steam at 75 pounds gauge pressure, .2089 pounds.

Total units of heat in 1 pound of steam at above pressure from water at 60 degrees, 1,151.

Total units of heat in 1 cubic foot of steam, 240 44.

Weight of 1 cubic foot free air at 60 degrees, .076 pounds.

Weight of 1 cubic foot air at 75 pounds gauge and 60 degrees, .456.

Units of heat required to double the volume of 1 pound of air at 60 degrees, 123 84.

Units of heat required to double the volume of 1 cubic foot of air at 75 pounds gauge, and 60 degrees, or to produce 1 cubic foot of superheated air at this pressure, 56 47.

Here, for convenience of figuring, we have assumed to double the volume of air by heating it. It is not practicable to do this, because the temperature attained would be too high to permit proper lubrication, etc. It is, however, easily practicable to increase the volume 50 per cent., and at about the same relative cost. With the heating apparatus as close to the air motor as possible, and even with the motor cylinder heated, not more than 75 per cent. of the apparent advantage may be expected to be realized.

Calculating Weights for Estimates—II.

By Joseph Horner.

Our next illustration is a bevel wheel, Fig. 4 (page 3). There is a major pitch diameter *A*, and a minor pitch diameter *B*. In estimating the sectional areas of the rings formed by teeth and rim, we shall take as our basis the *mean* diameter *C*, and *D*, thus:

Instead of reckoning the sectional contents of a single tooth and multiplying by the number of teeth in the wheel, we make a ring of the teeth. Take the "face" portion—beyond the pitch line (shaded at *a*, right hand and in plan), and turn this over between the "flank" portions—below the pitch line (*a'* left hand in figure and in plan). Say the tooth is 1″ long (mean dimensions are taken to average the taper in the rim) and the flank portion $\frac{9}{16}$″ long, as figured in section. Turning over *a* to *a'*, we shall have a ring of metal $\frac{7}{16}$″ thick, instead of $\frac{1}{2}$″, which would be one-half the total length of tooth. But the "flank clearance" between tooth face and tooth flank will be a set-off against this, so that $\frac{7}{16}$″ thickness of ring will be very approximately correct. So now, instead of taking the mean *pitch* diameter *C* of the wheel for the diameter of the ring of teeth, we take the *mean* diameter *E*, of the ring of metal, $\frac{7}{16}$″ in thickness. This is 1′ 10$\frac{3}{4}$″ diameter. We set down then our first item, as a ring *a'*, 1′ 10$\frac{3}{4}$″ diameter, × $\frac{7}{16}$″ *mean* thickness × 4″ width of face of tooth.

a' 1 ring, 1′ 10$\frac{3}{4}$″ diam. × $\frac{7}{16}$″ .... × 4′	=	125 cub. in.
b 1 ring, 1′ 10″ diam. × $\frac{3}{4}$′ × 4″	=	207 "
c 1 boss, 3$\frac{1}{2}$″ diam. × 5$\frac{1}{4}$″ × 1$\frac{1}{4}$′	=	72 "
d 6 arms, 6$\frac{1}{2}$″ long × 2$\frac{5}{8}$″ × $\frac{3}{4}$′	=	76 "
e 6 arms, 8$\frac{1}{2}$″ long × 3$\frac{3}{4}$″ × $\frac{5}{8}$″	=	119 "
		599 "

The rim *b* of the wheel has a mean diameter of 1′ 10″, and its mean thickness is $\frac{3}{4}$″ and width 4″, we set it down accordingly. The remainder of the wheel only embodies modes of dividing out, previously explained, so we will just jot them down as above from the drawing without comment, namely, the boss *c*, the flat arms *d*, and the vertical arms *e*.

The total number of cubic inches is 599.

Multiplying by .263 we have 157 pounds weight of metal, or 1 cwt. 45 pounds in the wheel.

Our next illustration is a bend pipe, Fig. 5. This is wholly circular. In thin castings of this type it is not usual to take the mean diameter of the ring or rings of metal into which we conveniently divide the castings, but to subtract the area of the internal diameter or bore from the area of the external diameter, as follows:

In the pipe shown in the figure, the lengths are given as is usual from the centers of the straight lengths *A* and *B* to the faces of the flanges *D* and *E*. We shall find it convenient to deduct the bend portion from the straight portion, to facilitate calculation. This gives us two straight portions, *A* equaling 3′ 6″ — 9″ in length, and *B* equaling 1′ 1″ — 9″ in length, and we set these down accordingly:

A = 1 tube, 2′ 9″ long × 4″ .....and 5″ diam.	=	234 cub in.
B = 1 tube, 4″ long × 4″ .....and 5″ diam.	=	28.4 "
C = quarter bend, 56 5″ circ. .....× 4″ and 5″ diam.	=	99 "
D and *E* = 2 flanges, 9$\frac{1}{2}$″ diam. × 1′ thick — 5′ hole	=	100.8 "
		462 2 "

The bend, *C*, happens to be a quarter of a circle, with *mean* radius *r* of 9″. So we say 9″ × 2 = 1′ 6″ mean diameter = 56$\frac{1}{2}$″ circumference, and we want one-fourth of that circumference, and set down *C* accordingly in list. Last we have two flanges, *D*

and *E*, each 9½″ diameter × 1″ thick. Out of these we have to deduct holes 5″ diameter, equal to the outside diameter of the pipe, because we took the total lengths of *A* and *B* over the faces of the flanges. We put down the flanges in the list and begin our calculations.

Taking *A* first we obtain the area of 5″; subtract the area of 4″ from it, and multiply by 2′ 9″ = 33″. Of course, we do not go through the process each time of squaring the diameter and multiplying by .7854, but just go to a table of diameters and areas. The result is, area of 5″ = 19.6″; area of 4″ = 12.5″; then 19.6 — 12.5 = 7.1″ area of cross-section of pipe, which × 33″ = 234″, which we set down accordingly in the list of items. Then ring *B* will also equal 7.1″ area × 4″ = 28.4″. The cross-section of the bend *C* is also 7.1″. The mean length of the bend is 56.5″ ÷ 4 = 14″, and 7.1″ × 14″ = 99″. The area of a single flange is the area of 9.5″ — the area of 5″ = 70″ — 19.6″ = 50.4″. There are two flanges = 100.8″.

The total sectional contents of the pipe is 463″. Multiplying by .263 = 121 pounds, or 1 cwt. 9 pounds in the pipe.

Another way to run through the weight of plain pipes, and any plain cylindrical work is to make use of a table of weights of pipes or columns, per foot run. In most engineer's books of reference these tables are given for cast-iron cylinders one foot long, of diameters ranging from 2″ or 3″ to 24″, and in thicknesses ranging from about ¼″ to 1″. These tables cover the range of all ordinary pipe and column dimensions, and, therefore, save some little time in subtracting areas. Again, it is often the practice, not to reckon out the flanges on a pipe as flanges, but to reckon two flanges as equal to one foot in length of the pipe, which in standard pipes is not far out.

The column, Fig. 6, is selected as a good illustration of the way in which calculation is simplified by the cutting up of irregular outlines into easy sections. I have divided it into no less than 12 sections, lettered from

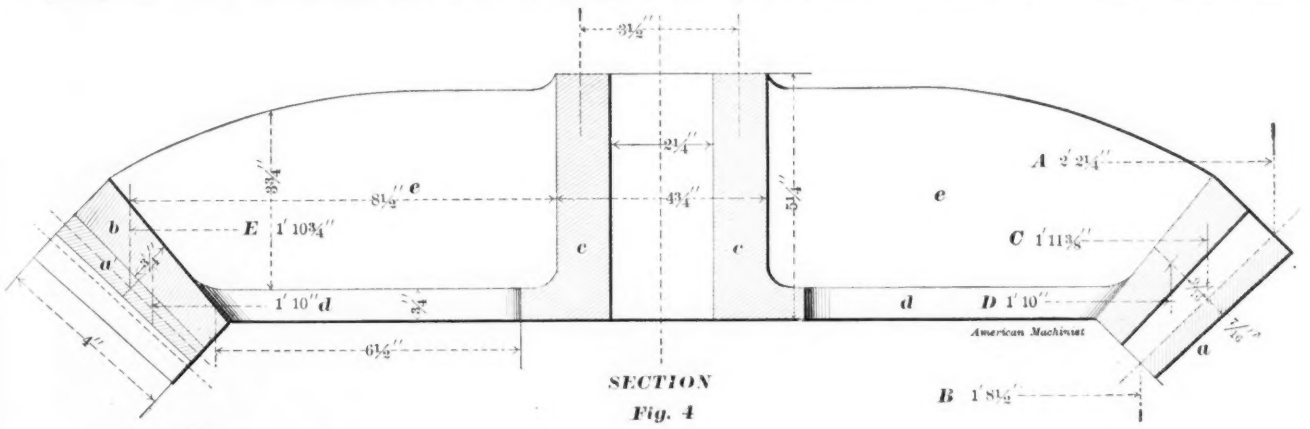


Fig. 4

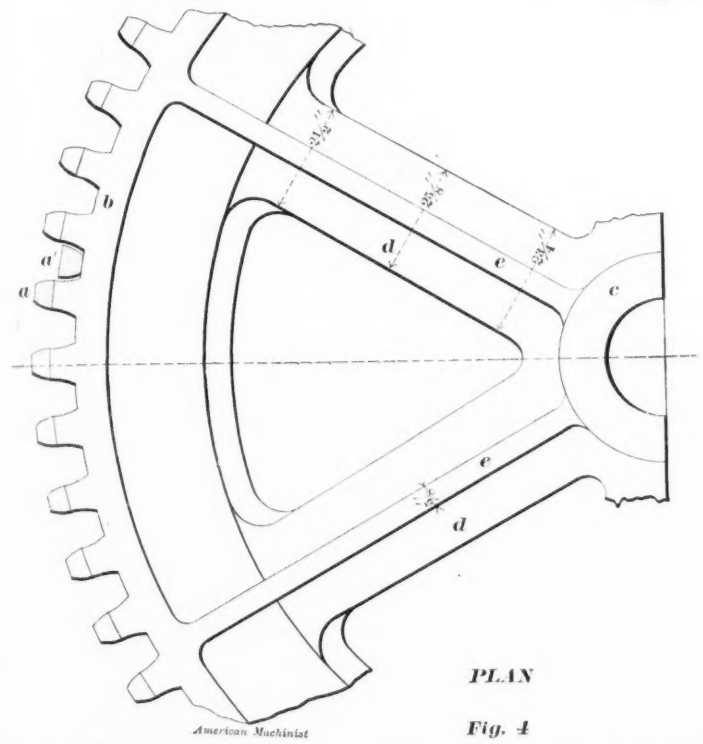


Fig. 4

A to *L*. These we will now take in detail. The items are set down in the following list, and by comparing them with the sectioned and dimensioned portions of the drawing, their identification will be easily effected without need of comment:

A = 1 plate 1′ 6″ sq. × 1½″ thick
minus hole 11″ diam. = 344 cub. in.

B = 1 ring 1′ 0½″ *mean* diam. ×
.....1½″ × 4″ = 235

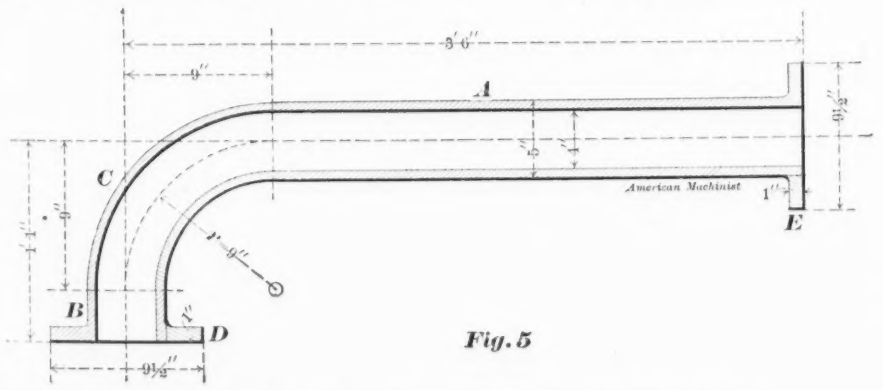


Fig. 5

C = 1 ring 1′ 3½″ *mean* diam. ×
.....1½″ × 2″ = 145

D = 1 ring 8½″ *mean* diam. ×
.....1⅛″ × 9″ = 264

E = 1 ring 8⅝″ *mean* diam. ×
.....1½″ × 2½″ = 82

F = 1 ring 8⅝″ *mean* diam. ×
.....1⅛″ × 7′ 2½″ = 2,569

G = 1 ring 10½″ *mean* diam. ×
.....1¼″ × 2″ = 72

H = 1 ring 1′ 4¼″ *mean* diam. ×
.....1¾″ × 3″ = 267

I = 1 ring 1′ 1½″ *mean* diam. ×
.....1¼″ × 4″ = 208

J = 1 plate 1′ 6″ sq. × 1½″ thick
minus hole 1′ 0″ diam. = 316

K = 1 plate 1′ 6″ sq. × 3½″ thick
minus hole 1′ 2″ sq. = 448

L = 1 plate 2′ 0″ sq. × 2″ thick
minus hole 1′ 2″ sq. = 360

5,310

Reckoning out

A = 1 plate, 18″ × 18″ × 1½″
minus hole 11″ diam. = 344″.

The total number of cubic inches in the column is 5,310. Multiplying by .263 we get 1,396.5, or 12 cwt. 2 grs. 1 pound weight of column.

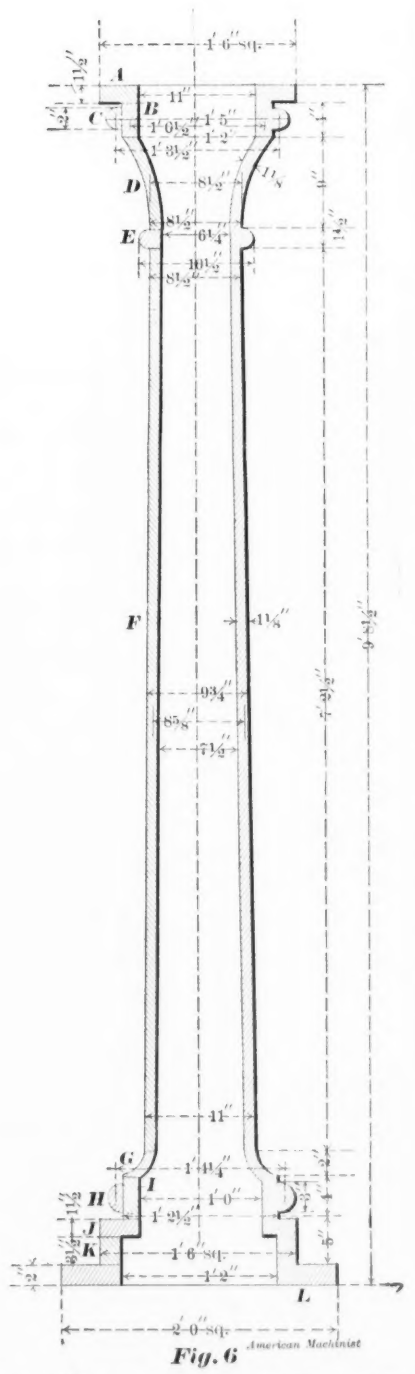


Fig. 6

It will be noted that the fractional parts of the inch are turned into decimals, as being more convenient for calculation than vulgar fractions.

It is a good practice in addition to the setting down of dimensions with reference letters relating thereto to make sketches of at least some of the parts in those calculations which involve a great deal of detail. I will not give examples of these, because I am not taking any intricate piece of work such as often occurs in the shops. The illustration of such intricate work would occupy very much space, needlessly, because much of it would be repetitions of the same kinds of calculations, circles, plates, etc. But in such work risk of error is avoided by making little sketches of rings, brackets, flanges, plates, webs, etc., opposite the reference letters and dimensions. They do not add perceptibly to the time spent, and they indicate at a glance the parts referred to.

Calculations of weights are not always made so much in detail, and with the exactitude with which the foregoing examples have been worked out. The necessary time would not be available either in offices or shops. In the office, for example, an estimate has often to be got out within a day—an estimate involving many scores, perhaps hundreds of castings and forgings, and then an approximation to the actual weight can only be attempted. Moreover estimations often have to be based on general drawings only, fully detailed drawings not having been yet prepared, and in those cases an absolute estimate is out of the question. So also when the foreman patternmaker or molder has to reckon out the weight of a casting it is often done with a view only, or chiefly to learn what weight of metal will have to be melted for it, or what ladle should be used. Then a fair approximation only is needed because the good allowance necessary for pouring basin, runners and risers gives a margin to work on. Such approximate calculation can be performed with great celerity when a man has had a little experience therein.

In many cases no special calculation has to be done at all, as in the cases of standardized work. Suppose a firm is engaged in the manufacture of a specialty. Then the weights of different machines or motors or types of structional work are known, both the weight of each component part and the total weight. If another machine or motor is wanted of a size not kept in stock, or of a structure which has not been made before, then an approximate estimate is made proportionate to its size based on that of the machine, or motor, or structure nearest thereto in size and weight. Still this can hardly be called estimation in the sense in which I am using the term in these papers.

When getting out approximate estimates by direct calculation there is a good deal of mental work done which is not put down in figures. Thus in running through an intricate piece of work certain allowances or sets off are made. Certain holes will be set off against certain lugs, brackets, corners, angles, and so forth, when one appears to about counterbalance the other, so that one would not be set down at all in the calculations, but allowance would be mentally made for it.

Again, instead of calculating areas and sections very exactly a good deal of rough work is done in the way of mensuration and of deduction, and the results brought out into plain forms adapted for the utilization of certain tables. Flat and angular surfaces are either brought into square feet, or into feet square, and of a definite thickness. Curved surfaces, of whatever curve, are either brought into flat surfaces of square feet, or feet square, or into annular rings. In either of these forms the weights are easily obtainable direct from tables.

Not only are tables designed for use with a given metal, employed, but tables are also utilized for metals other than those for which they are designed. Thus it is very easy and convenient to use tables of weights of wrought iron, for cast-iron and brass. Tables are given for the weight of a superficial foot of various thicknesses, and of the weight of a foot run of bar-iron of various thicknesses and widths, and these can be utilized for any other metal by the employment of a suitable multiplier, often saving the trouble of some considerable calculation, when a table of similar sections is not available for the metal or alloy required. Thus the multiplier .9538 converts the weight of bar iron into that of cast-iron, .929 steel into cast iron, 1.15 bar iron into gun metal or copper. Not that any single

calculation in itself amounts to much, but when hundreds of separate calculations are in question, a trifle of time saved on each makes a lot of difference in the sum total.

Even in calculations for bringing cubic inches into pounds many do not use the multiplier .263 given for cast-iron. It is more accurate than any other method. But for very rough estimating some simply divide cubic inches by 4. This, however, would make a good deal of difference in a big casting. But a very fair approximation is obtained by dividing inches by 4, and the quotient by 20, and adding the two together thus: Taking the last example, the column, Fig. 6, which contains 5,310 cubic inches, and weighs 1,396 pounds; dividing 5,310 by 4 makes the weight 1,327 pounds, or 69 pounds too little; dividing by 4, and then the quotient by 20, and adding the two results together gives 1,393 pounds or only 3 pounds too little on 12 cwt. odd. I will give some examples in the next article illustrative of the foregoing remarks.

The degree of accuracy within which the estimation of weights has to be done varies. In getting out weights from a general drawing, from which much of detail is frequently omitted, a good margin must be allowed. If such a drawing is made, say, to ¼ inch or ½ inch scale, it is obvious that minute dimensions cannot be determined from this, and the estimator must therefore use his judgment largely in determining proportions of parts as he goes along. Here the mechanical instinct developed through long practice is of great value. Again, in estimating weights for the use of the foundry, no very precise results are required. In estimating for the less costly metals, again, a less degree of accuracy is necessary than in estimating for the more costly alloys. Estimates for gun metal would have to be done more carefully than estimates for cast-iron; and estimates for forgings more carefully than for cast-iron. When a small quantity of castings or forgings of any metal is required, less care in detail would be taken than when large quantities are wanted, since the difference of two or three pounds only on a single piece of work would make a considerable difference when hundreds were in question. When large numbers of similar castings in gun metal, phosphor bronze, delta metal or steel are wanted, it is necessary to reckon out the weight to the minutest detail. And then, too, it is usually the practice to check the first casting made, and if it turns out above the estimated weight, the pattern is altered, if practicable, so that the weight shall not exceed that estimated.

Railroads and Madness.

In this country the first construction of railways was opposed by some sagacious minds which were perturbed by the thought of the consequences that might ensue if a cow should happen to stray upon the line. It appears, however, that in Germany the projectors of the first lines had to face a much more terrible possibility than even the extinction of the bovine race. They were warned, and that in all seriousness, that their undertaking would indubitably have the effect of spreading insanity among the traveling public. Among the papers of the Nuremburg Railway Company—the first to construct a line in Germany—has been found a curious protest from the members of the Bavarian Royal College of Medicine. This document declares that all traveling in vehicles drawn by locomotives should be prohibited in the interests of public health. Such a rapid motion, it is pointed out, cannot but produce in the passengers the mental affection known as *delirium furiosum*. Even should the passengers themselves be willing to run this terrible risk, it is, nevertheless, the government's duty to protect the public. To the mere onlooker, moreover, the thing is positively dangerous. A mere glance cast at a locomotive traveling at a very high speed is enough to produce the same mental derangement in the beholder. Even if passengers are to be allowed to ruin their mental powers, it is, at least, absolutely necessary (says the Bavarian *Faculty*, in conclusion) that a 10 foot wall should be built on each side of the line throughout its entire length, so that the flight of the iron horse may in no way unsettle the public eye and mind.—*Westminster Gazette.*

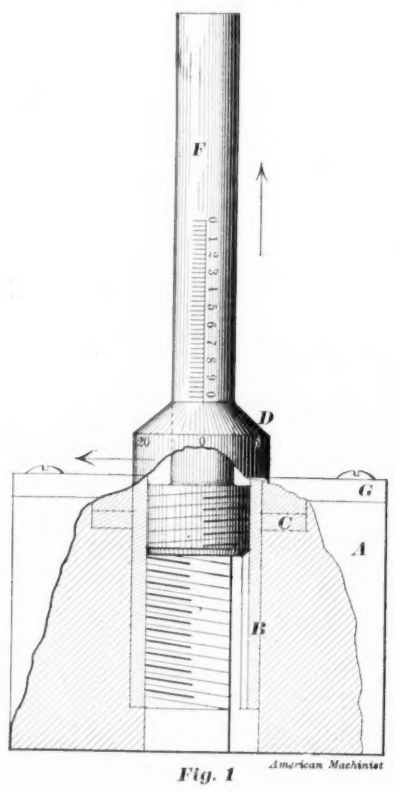


Fig. 1

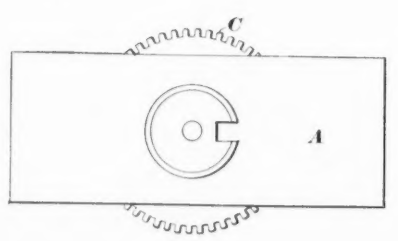


Fig. 2

Height Gauge for Planer.

In the modern machine shop where progressive ideas prevail some means of setting planer tools accurately to given heights are usually adopted, these sometimes taking the form of standard blocks ground and lapped to size. The tool which we illustrate herewith is intended to furnish a means of readily setting a planer or shaper tool to any desired height and makes use of the micrometer principle.

It consists of a block *A*, Fig. 1, a nut *B*, with knurled flange *C* and beveled edge *D*, upon which are the graduations, 25 in number. A standard *F* threaded a short distance on the lower end as shown, has threads cut on it 40 to the inch.

The standard *F* has an axial line graduated into fortieths of an inch and numbered the same as an ordinary micrometer caliper. A movement of one division on the beveled edge *D* from the line on the standard *F*, raises or lowers the standard .001 inch. The bottom of the nut *B* abuts on the recess in the block *A*, and the top is kept from end motion by the cap *G*. The bottom or threaded part of the standard *F* is splined, and a key in the block *A*, Fig. 2, prevents it from rotating. In operation the nut *B*, being turned by moving the knurled flange *C*, raises or lowers the standard.

It is obvious that different size standards could be fitted to the base or blocks and parallels could be placed beneath the gauge to raise it any desired number of inches.

This gauge is, of course, more useful than a set of blocks, for it can be set to any desired size within its capacity, in thousandths of an inch, and is quickly adjusted. It has been patented by Messrs. Edwin H. Carter and J. J. Beard, of Providence, R. I.

Coal is now being shipped from this country to England—"Carrying coals to Newcastle."

Intelligence Conveyed by Drawings.

By B. F. Spalding.

The three professions which have to do with man's morals, health, and rights, are justly conceded to be of supreme importance, as they deal with matters of the greatest moment. But such is the immensity of the sphere of their operations that it exempts them from strict accountability. As "man lives by sufferance of his fellow man," they must work to suit their employers, but they do not have to guarantee their work.

Less exalted beings, whose calling it is to treat matter in grosser forms, are responsible for their work. They must, like the others, do what their employers direct, for they must suit those they work for, but if they go wrong they must do it under protest. Their responsibility, like their materials, may be weighed and measured.

It is sometimes difficult—impossible—to follow directions, and still give satisfaction. Then it is a good thing to be able to show the directions; also the protest.

About the first thing to be looked at in endeavoring to suit people, is to find out what they want. It would be an excellent thing if the person who wanted something made, always knew just what he wanted. One of the great advantages of drafting is that by the time a drawing is completed, the person who makes it has had a fair opportunity to ascertain with some degree of certainty what he wants himself, for he has advanced it a step beyond the airy fabric of a vision, in which it first appeared, and has constructed it in permanent lines. When some one has added to these the bones, flesh, and blood, this pale ghost will be materialized.

In machine building, the first flights of the designer are to the blacksmith, patternmaker, and woodworker. These mechanics must, in some sense, be mind readers sufficiently to possess themselves of the novel ideas of others. Some things they must be cognizant of by virtue of their craft. To have learned their trades they must have gained a knowledge of the methods of making some standard articles. A country blacksmith, for instance, must know how to make plow irons, horseshoes, and the iron work of carts and wagons. If a man orders a fifth wheel for his buggy, the blacksmith does not expect to be furnished with a complete detailed drawing of it, but goes to work and makes it out of the knowledge which constitutes his general stock in trade.

A toolsmith also has his own peculiar acquisitions of knowledge. His tools have a family resemblance to others of the same kind, but are marked by certain distinguishing personalities which originate in the pattern fixed before his mental vision, which he faithfully reproduces. If a diamond point, shovel nose, racker or offset right hand side tool is ordered, he makes it to the model he carries in his own mind, but if some one, having an unusual cut to make, requires a special form of tool which he thinks would perform the operation with facility, the blacksmith must have some way of reading the mind of the man who wants the tool, and this man may not have the faculty of opening out his mind to be read, cannot express himself intelligibly. A drawing will reveal the image which exists in his mind. If he can make a drawing of it correctly, most any one can read on that what is written in his mind, but the greatest puzzle, and the most perplexing, is to read the mind of a man who thinks he can make a drawing when he cannot. He writes A when he intends to write B; he sets down 7 when he means to set down 9 and hence his efforts amount to 0, nothing, as far as conveying intelligence is concerned.

Proof of intelligence is in recognized expressions. Its existence, like that of electricity, becomes known by its transmission; it is revealed by motion. Horses agree to stand head and tail in the summer fields to switch flies from each other. Crows inform each other that "a horse lies dead on yonder plain." Their mode of expression is unrecognizable by us, but we recognize the fact that it has been made and understood by the subsequent proceedings.

The Poet Rogers preserves in verse the story of an idiot boy in the Swiss Alps, who gave no sign of sense whatever, until he was actually shocked into expression in his eighth year, when he one day rushed in to his mother from the playground before the cottage door, with an ear piercing scream, and wild upward motions of his eyes and arms, which correctly conveyed to her the startling intelligence that an eagle had flown away with her youngest child. His twin brother, born deaf and dumb, and hence a natural pantomimist, ran in, and hid behind her apron, shocked beyond expression by the same scene which had shocked the lesser intelligence into expression; one only expressing his terror, and the other giving an intelligent account of the occurrence which caused it.

An idea is conveyed when it has been expressed in such a manner that the expression has been understood, and the idea stands in a clear light in the mind of the one who receives it in the same identical form that it had in the mind of the person who expressed it. Failure of conveyance may be the fault of either the sender or receiver. Any motion, sign, sound, signal, symbol, delineation, word, or description, that conveys an idea to any one, is a competent expression to that one at that time and place, and under the prevailing conditions, even if it is necessary that that one must be of superior intelligence, or of ordinary intelligence, inordinately alert, as two card players in collusion; or, like the Swiss mother, under a strain so tense that the slightest suggestion awakens in full force the keenest perceptions.

Proper drawing, graphic delineation, has been accounted the most universal form of expression, but it may fail of conveying the idea, either through the fault of the draftsman, or of the reader. But the blame of failure must finally rest on the draftsman. It is his business, in whom the idea is lodged, to absolutely convey it to the person whom it is desired shall possess it. It is his business to express it, not only so that some one can understand it, but so that this particular person, who is to get it, shall have it presented to him as a gift is presented, and in such a way that he will have a full conception of it. It will not do to say, "If you don't understand it I can't help it, I don't agree to find brains for you."

A blacksmith made a very pertinent remark, some over thirty years ago, when he had looked over a drawing, which had been handed to him. He said: "I suppose there is some talk goes with this drawing." No false pride, no desire to appear bright, no fear of being thought stupid, should prevent a workman from making full and free inquiries about a drawing which he is expected to work to, and no false pride or stupidity should prevent the draftsman or foreman from patiently explaining every doubtful point in the most full and explicit manner, rendering every matter plain and clear, and being assured that it is perfectly understood.

If the draftsman makes his drawing according to the conventional rules of the art, the foreman should be able to understand it, and inform the workman of everything in regard to it which requires explanation. If he is not, let him become so. A peculiar disadvantage in this country is that we have so many workmen who are not native-born, and whose knowledge of our language is perhaps not much superior to our knowledge of theirs. It is a common fault with them that they are over anxious to appear to understand. They wish to lighten as much as possible the weight of ignorance of the language which handicaps them in the race with their fellow workmen. It is very trying to a foreman, after he thinks the workman is fully informed on every point in connection with a drawing, to find, after he has got the piece forged in a supe

rior and workmanlike manner, that he has made it left-handed, or of iron, when it should have been steel, or that he has made it in any other shape, form or fashion, that excellently illustrates the beauties of forging, and utterly unfits it for the purpose for which it was designed. He would like to blame the workman or the draftsman, or anybody else but himself, but honestly, he cannot. If he did not understand the draining, he ought to have understood it; and he either gave the job to an incompetent workman, and neglected to exercise the extra supervision which was necessary, or he failed to convey to the workman an adequate idea of what was wanted.

Various opinions are entertained in regard to the order in which the different views of a drawing shall be arranged on the board in relation to each other. Some queer theories must be held if they correspond with the practice. The irregularities of practice, however, probably arise from heedlessness and entire disregard. A little consideration will show that it is of more importance than casually appears, that there should be a regular convention in the manner of placing the several elevations of an object; that there should be a fixed and not a variable rule of turning the object, so to speak, in projecting the different views. Such a system has been quite generally carried out in some of the older mechanical establishments of the country. It was long followed in the principal shops in New England while practical workmen were directing. Its existence often determined doubtful points of right and left, better than the distinctions of dotted and full lines.

By this plan the horizontal and vertical projections are made with the object at rest on the horizontal plane. To illustrate, a brick will do. First, plan, brick lying down flat. View from top shows it 8 inches long, 4 inches wide. Second, side elevation, board shoved behind brick, and figure of brick marked on it, 2 inches high, 8 inches long. Third, end elevation, board raised on the right and figure of brick drawn on it, 2 inches high, 4 inches wide. This is the same in effect as though the draftsman marked around the brick as it laid flat, then turned it up, directly on the side from him, scratched around it, and then turned it up on the right end, and scratched around it again. This scheme discountenanced acrobatism and all manner of inebriated posturing in the object and conserved for it a respectable representation.

The horizontal projection of a coffee pot, technically speaking, showed the view of the coffee pot from above. The round bottom showed in full lines, until they were broken by the full outlines of the handle, on the right, and of the nose, on the left, when they became dotted until these intervening obstructions were passed. The front elevation represented the coffee pot standing, or, more properly, sitting, on its bottom; the conical body; the graceful curves of the handle, at the right; and the pointed aspect of the nose, at the left. The end elevation, if it was desired to give a full face view of the nose, was at the right hand of the front elevation; but if it was to show the full lines of the handle, it was at the left hand, and showed the pot still sitting on its bottom, and exhibited a full view of the back of the handle.

Thus, when the several projections were on the same sheet, the part of an object represented could always be determined by the relative position in which it stood to the plan. This method appears preferable to the no-method style which would permit the front view of the coffee pot to be represented top side up, under the plan. There are some, however, who can see nothing incongruous in the latter representation. But if it is turned naturally, a proper representation of it, if it is placed under the plan, will show it top side down.

Let us go to the shop and see how an anvil would be projected by this method. The horizontal projection would be as though the outlines dropped by gravity upon a board placed beneath its base, those of the top falling on those below, and shattering them. Except for the dotted lines the anvil would look on this plan, as it would appear to the blacksmith standing in his place, and bending over it, as though scrutinizing it from the top, to see if any scandalous usage had battered dents in its face during his absence. The outlines of the face and horn would show full, and so also would those of the base, except where they were crossed and hidden by the superior parts, and there they would be shown dotted.

The side elevation would be as the anvil would appear to the blacksmith if, by an unparalleled expansion of his limbs, he stepped back an infinite distance, everything getting out of his way, and then drew the outlines of the anvil as it stood before him. This view would occupy a position on the board above the plan. The horn would be shown at the left.

An end view exhibiting the full outline circumscribing the horn would find its proper place on the right side of the side view, and one, showing in full line the shape of the other end, would be in correct position on the left. Each of the elevations would represent the anvil sitting on its base.

These four views of an anvil would probably be a proper drawing for a blacksmith to make one by, but might not be an adequate conveyance of the full idea of form to a patternmaker, who was not necessarily by knowledge of his craft familiar with the peculiarities of anvil construction. For him sectional views cutting across the horn at its junction with the body, and again at the line of change from square to round, would make the drawing sufficiently intelligible, so that in it he could read the mind of the designer.

An evidence that persons who are not familiar with the object represented require the greatest specific information is found in the fact that of a number of different patterns of miniature anvils for advertisements, which were professed copies direct from standard anvils, the one that came the nearest to being of correct proportions was twice as wide across the narrowest part of the base, as it was across the face. This was wrong. Blacksmiths prefer that these measurements shall be equal, and that the vertical section across the middle of the anvil shall be practically a right angled parallelogram. Things which are of great practical value to those who use them appear as matters of indifference to those who have no practical acquaintance with them, and hence are liable to suffer from inattention.

To the man who thinks he can make a drawing when he can't may be added the one who prefers to make a pretty picture rather than a readable technigraph, and after him comes the man who can make a drawing but makes a mistake instead, a "sniv" some call it. A blacksmith once had a drawing brought to him by a good mechanic and draftsman, but as Mr. O'Boyle remarked, if the piece had been made to agree with the three views given of it, it would have been two pieces instead of one. It was a box tool for a turret screw machine—they were quite complex in their early days. He forged it to the intent which could be fathomed by anyone, not perverse, from the drawings. The trouble was that one of the views expressed too much—told a lie. The first one to call the attention of the designer to the mistake was the planer. The draftsman acted as though the planer was to blame for the error and hated him for it forever and ever.

Some ten years ago a gentleman with a penchant for fecundity invented a machine. The only drawing he ever made of it is still in existence. It is a very off hand sketch in lead pencil. To the careless observer it represents half a dozen long feathers left sticking in the tail of a hen pecked rooster. This is all the drawing which was made of the machine which was constructed from it in iron and steel. The machine gave perfect satisfaction to the designer. When completed it was composed of 60 or 70 components. It furnished a very good example of mind reading. The mind reader did not know what was in the designer's mind better than he did himself, but he was able to give a fuller expression of it by materializing it and setting it forth in a more palpable form.

Professor Mahan, under whom Grant and most of the other generals of the late war studied engineering at West Point, said, "There is no person, whatever his profession, but at times has need of drawing as an auxiliary to render his ideas perfectly intelligible to others." Stories which illustrate this saying are told by Alexander Dumas and by Nasmyth, the hammer man. If these men were not so eminent we might suspect that one tale suggested the other. They show that what might be competent expression to a Norwegian would not do for a German:

Mr. Nasmyth said he was traveling in Norway and "one day in a wild, out-of the-way place reached an inn, very hungry, but unable to make the hostess understand his wants by anything he could say. He was considerably perplexed till he happily thought of his pencil. He drew a dish steaming, a plate beside it with knife and fork, a bottle and a wine glass. His hostess looked at it and intimated that she knew what it meant. He went out for a stroll and on his return found the picture realized. The bottle, the wine glass, the plate, the knife and fork, and the covered dish. When he sat down his hostess lifted the cover displaying a fine hot fowl that sent forth a cloud of steam. Lucky Nasmyth!

Not so lucky was Dumas, and yet as expressers of ideas, where is the comparison? The circumstances are similar, only Dumas was on the border land of Switzerland stopped by the rain; horse sinking in mud up to his knees; driver wet to the bone. Dumas would not have entered the little German inn, so wretched, except for his great philanthropy. If he hated anything it was sauer kraut, and when they imposed this "infamous pleasantry" upon him, repeatedly, he gave it to the dog. The astonishment of his hostess was "mountainous." "If you don't like sauer kraut what *do* you like?" "Anything but that." It was all she had. A luminous idea lights his soul. Mushrooms! the country was famous for them, but—he could not remember the German name. 'Some,——some——. How do you call it in German? Some——" "Some——?" repeated the hostess mechanically. "Eh? yes; some——." "At this moment my eyes fell on my album. 'Wait,' said I, 'wait!' I then took my pencil and on a beautiful white leaf drew, as carefully as I could, the precious vegetable which formed for the moment the object of my desires. I flattered myself that it approached as near to a resemblance as it is permitted for the work of man to reproduce the work of nature. All this while the hostess followed me with her eyes, displaying an intelligent curiosity that seemed to augur most favorably to my prospects. 'Ah! *ja, ja, ja* (yes, yes, yes),' said she, as I gave the finishing touch to the drawing. She had comprehended—the clever woman—so well comprehended that five minutes after she entered the room with an umbrella all open. 'There!' said she. I threw a glance upon my unfortunate drawing—the resemblance was perfect!"

The baggage smasher had dropped the trunk from the car and knocked one end of it out. "What did you let that trunk drop that way for?" exclaimed the irate owner. "I beg your pardon," responded the baggage-smasher innocently; "I could have dropped it on the other end just as well if I had known you wanted it that way."—*Detroit Free Press.*

A woman, Mrs. Blanche S. Leathers, wife of Capt. B. S. Leathers, owner of the steamboat "Natchez," has received a master's license, after undergoing a rigid examination.

The Forth Bridge is to be repainted and 50 tons of paint will be required to give it a single coat.

LETTERS FROM PRACTICAL MEN.

Piecework.

Editor American Machinist:

The advantage of piecework over day work, from a workman's point of view, is first the increased wages, which he desires to make, and second the experience of working (to some extent) for himself. The claim that a workman should do as much work by the day, as by piecework, made by a "Superintendent" is not strictly true, under the present system of shop management. As an instance, a workman by the day, sees a chance (or thinks he does) to improve the quality or increase the quantity of his work, by having a fixture made for the purpose. He suggests making it to his foreman, who may, or may not adopt his idea, according to his judgment, or he may adopt the idea, and take all the credit to himself. Whereas, if he has the job piecework, the workman would be allowed to design the fixture, and the gain or loss would be his, and the chances are that there would not be much loss about it, if the workman is experienced on the job. A workman will generally exert himself most, for his own interest or advantage. This is human nature; and if he finds the system of job work, operating to his disadvantage, by a series of cut downs in the price of the job, for a time he may exert himself as usual, generally increasing the quantity of the work rather than the quality, and the result is as I have frequently observed, that it costs more to erect the machines, than the difference in price, of day work and job work to the firm by which he is employed, and the assembled machines are never just right, thus injuring the reputation of the shop.

And the workman loses faith in the system of piecework, and prefers to work day work again. Or he will not do all he can, but allow himself to make a small advance on his wages, and be content with that. The impression seems to be amongst the workmen of experience whom I have talked with on this subject, that the system of piecework, as generally managed, is unfair to the workman, as the price is usually set by the office or the foreman, allowing the workman who can work the quickest, a fair advance on the average wages, leaving the slowest unable to compete. It is not always best to use, even the average speeds and feeds, on the different metals, as sometimes the metals are so hard, as not to allow it, and the speed should be reduced in preference to the feed. I have known the price of job work to be reduced because the metal came so soft as to be easily worked, while the wear on the cutting tools was at a minimum; and then the metal came hard again, and the loss came on the workman.

I have been employed in shops, where most of the work was done by contract, by the superintendent and foreman of the different departments, and the workman got below the average wages, and the work turned out was not (nor could it be expected to be) of the best quality, but the contractors made money, all the same, until the "firm" got "on to them," and went back to day work again.

In conclusion, I wish to say that, in my opinion, a system of piecework properly and fairly conducted, is of advantage, both to the workman and his employer.

It gives the workman a stimulus to exert himself to do his best, and it gives his employer the best service the workman can give.

J. T. G.

Providence, R. I.

Notes on Steam Boilers.

Editor American Machinist:

I find many steam engineers who cling with a beautiful child-like faith to what is termed the U. S. Government rule of determining the strength of boilers. The cheaper editions of books for engineers contain it, and the trade papers usually work it over quarterly to the edification of the night watchmen—their reading public.

This rule is as follows:

Where TS = tensile strength in pounds per square inch,
T = thickness of plate in inches square,
R = radius in inches square,
6 = factor of safety,
WP = working pressure in pounds.
Then:

$$WP = \frac{TS \div 6 \times T}{R}.$$

Usually there follows a foot-note stating, add 20 per cent. if double riveted. The value of this foot-note should be noted. It calls our attention to riveting. Otherwise we would not think there were any more rivets in the boiler than are mentioned in the rule itself. True, we can't expect to find either hand driven or snap riveting in a formula bearing the august title of United States Government Rule; but then rivets do occur, good, bad and indifferent in boilers, and come to think of it they some way should enter into the calculation, if we care anything for the strength of seams, pitch, lap, etc.

However, we can neglect the riveting for the present, for is there not a big factor of safety ever at hand in which is reposed a confidence—a faith—at once reverent and bigoted? Argue as you may about the riveting, the true believer points you, with pity for your density, and sorrow for irreverence, to the factor of safety 6.

When you run against this daily for a few years, it gets to be an old song minus harmony, and I submit it ought to be changed. For example, take a 50-inch tubular, 60,000 *T. S.* ¼-inch steel, single riveted would give us 100 pounds working pressure by this rule, and the people who pin their faith to its correctness fully believe this factor of safety is 6, or that 6 times the working pressure is the bursting pressure. The error of it is the strength of the seam. The single riveting, properly designed and well executed, gives 56 per cent. the strength of the plate. Therefore, let this enter our formula as a necessary factor in getting at safety, taking also 71 per cent. for double riveting, as the case may be. Our rule then would be:

When TS = tensile strength of plate,
T = thickness of plate,
R = radius,
WP = working pressure,
.56 = for single riveted,
.71 = for double riveted.
Then,

$$WP = \frac{TS \times .56 \times T \div 6}{R},$$

and in the case of the 50-inch boiler, our working pressure would be 54 pounds. I do not argue that this is too small allowable pressure for this boiler. But the point I enter is this: Let us have a factor of safety determined by accurate values. While I am aware that the larger number of your readers know the weakness of the old rule, yet there are many superintendents and engineers of plants who have accepted it without an analysis, and are using it. Some of these men consider that 15 years' service of a boiler would have no effect on the rules.

Who will tell us what amount the factor of safety should be after that service? Tests of sheets vary widely, some being only 18,000 pounds, while others from the same old boiler show 50,000 pounds *T. S.*

As in getting at the strength of a chain the weakest link is sought, so in boilers a plain every-day logic ought to obtain everywhere. Tom Thrall.

"Fraudulent Testing."

Editor American Machinist:

Mr. Wm. Kent's letter, in your number of August 2d, shows that he has not read your article in the right way, as you do not refer to the acceleration of the pulling or straining mechanism, but to the inertia of the weighing mechanism. Hence your correspondent puts the cart before the horse, and applies his mathematics incorrectly. But, taking his own formula, and applying it to the balance weight, which is kept floating at rest, or zero (0) when the machine is properly and conscientiously used, will show that such a machine can be used as explained in your editorial.

In a weighing machine of lever ratio of 8,000, and a balance weight of 25 pounds, say, an increment of load on the specimen tested produces an acceleration, and the faster this continuous increment of load is applied the greater will be the upward acceleration of the balance weight. Now, in order to prevent this upward acceleration, the balance weight is kept at such a point that not only the load carried by the specimen, but also the inertia of moving levers due to increment of weight is balanced. It takes but the force of ½ pound on lever to balance a force of 4,000 pounds on specimen, and as the balance weight is 25 pounds, we have,

$$m(v_1 - v_0) = \frac{w}{g}(v_1 - v_0) = \frac{25}{32.2}(v_1 - v_0) = \tfrac{1}{2};$$

or acceleration necessary to produce force of ½ pound = 0.64 foot per second, while the balance weight actuated by gravity alone would move with acceleration of 32.2 feet per second, if the other parts of the mechanism were entirely balanced and had no inertia resisting their motion.

As your correspondent assumes acceleration of straining mechanism as 1 inch per second, and this is transmitted to balance weight through levers, the whole mechanism weighing about 500 pounds, might produce a force of,

$$\frac{w}{g}(v_1 - v_0) = \frac{500}{32.2} \times \tfrac{1}{12}\text{ foot} = 1.3\text{ pounds};$$

if this acceleration were but .38 inch per second it would have sufficient force to require an advance of the balance weight on beam to correspond to 4,000 pounds on test specimen. "C."

Gas Engines for Electric Lighting.

Editor American Machinist:

In your reply to Question 360 you describe the operation of gas engines and show why the explosion takes place at one end, and then only once in two revolutions. If the load is right, if the explosion does not take place at the second revolution, it will not explode until the fourth. The engine must have secured sufficient impetus to carry it through the two revolutions, and, if necessary, through the four.

Put three or four of these engines on a shaft giving power for incandescent lighting; so long as the engines take gas alternately the volt gauge shows all right, but when they get around so that all take gas at the same time it gives a brilliant light at times, as it will go up and down some 6 volts. The only way to do in such a case is to set the voltage so that it goes three above and three below normal.

Gas engines do not take an overload kindly, and a short circuit or throwing on a number of lights suddenly is liable to shut the whole thing down. There is a good deal of machinery and lots of possibilities about gas engines.

A little dirt under a valve, a gust of wind blowing out the igniting flame, a cooling of the igniting tube, a failure to ignite when everything appears all right, make things interesting in an electric station.

New engines run along very nicely, but after four or five years of service they are liable to give anxiety. The writer recently heard of a station that was equipped with both gas and steam, but gas gave the best results, steam only being used as an auxiliary, and thinking to see a novelty a trip was made there only to find the old story: gas engines "no good;" "use steam altogether." W. E. Crane.

Care of Wet Tools—Removing Water from Watches and Small Machines—Grinding an Anvil.

Editor American Machinist:

I wish to add a little to the discussion relating to preventing the rusting of tools. It is very aggravating to find, upon taking a fine tool from box or drawer, that a coating of rust more or less thick has formed owing to dampness or humidity of the atmosphere, or moisture in the tool box, wet tools, etc. In some localities, particularly in the Southern Atlantic and Gulf States, it is almost impossible to keep tools bright by ordinary means, and some machinists have been driven to the necessity of thickly covering tools with vaseline before laying them away.

There is a way by which tools may be kept bright while in the tool chest, and they may be stored for years and keep perfectly clean, with only an occasional looking at. In fact, there are two methods. One is by the use of quicklime, the other by the use of sulphuric acid (oil of vitriol). Both substances have so great an affinity for water that they will extract it from almost any substance containing it with which they may be brought in contact. Even air gives up its percentage of moisture when confined in the presence of lime.

A box of lime placed in a tool chest will then, by virtue of its affinity for water, extract every particle of moisture from the air confined in the chest. The lime will also gather in all the moisture that may be on the tools themselves. It is only necessary to use a comparatively small piece of lime and to renew it occasionally. Secure a two quart Mason jar, such as is used for canning fruit and berries. Fill the jar with pieces of good, hard lime. The pieces may be about as big as eggs, and a large lump of lime can be easily hammered into shape. Pack the jar full of lime, screw the cover down tightly upon the rubber packing, and the lime will keep indefinitely.

Rig up a little brass or iron box and fit it with a wire cloth cover. Drop a bit of lime into the box, put cover on firmly, and pack away among the tools. If the lid of tool chest is kept shut the lime will capture all the moisture—and hold it, too. Stir up the lime once in a while, and occasionally replace by another bit from the fruit can. A box of air slaked lime kept tightly covered is better than a box of sawdust to put tools into when they come back to the shop from being out in the rain or on a wet job. Throw the tools right into the lime, shuffle them around in it, then wipe off the lime and the tools are well dried.

Sulphuric acid also picks up all the loose moisture that is lying around. A lead cup and the acid may be substituted for the lime box in a tool chest. The acid is the most powerful and works best in certain cases; while for general use the lime box is best, owing to the freedom from damage should the contents be spilled among the tools. If ever any microscope slides have to be put up, always put them together after being exposed in a tight box with a cup of sulphuric acid. If a watch drops overboard and is recovered very wet, the best course is to hand over the ticker to the nearest watchmaker, but if one is not at hand, the watch can be saved by proceeding as follows: If wet in salt water, proceed *at once* to wash thoroughly in fresh water. Take off the cases, open the works as much as possible, and *churn* the works up and down in a pail of fresh water until all the salt has been removed.

Next souse the watch in alcohol. Do this two or three times in fresh alcohol, 90 per cent. at least, and the higher the proof the better. The barrel containing the mainspring should be removed, opened and treated as above. Evaporate out all the alcohol, then place the watch in a small box with a cup of strong sulphuric acid, and a few hours' confinement thus will serve to remove every vestige of moisture. The watch must be oiled before it will run satisfactorily after having been treated with alcohol. Small machines which have been wet may be cleaned and dried in the same manner, and I have had fine results from the method. "Alkaline," or wood alcohol, may be used instead of the higher-priced, ordinary alcohol, but I do not like it quite as well.

In addition to the advice given in Query 363 (August 2d, page 9), regarding the facing up of an anvil by drawing the temper, planing and re tempering, I find from personal experience that the best way to harden the face of an anvil is to heat as described—to a cherry red—then set the anvil right side up in the water tank as described, but instead of the stream from a hose, attach a rope or chain tackle to a cake of ice and lower it right down quick as soon as the anvil touches water upon the face of the anvil. By doing thus, the heat is carried away so quickly that the hot body of metal below the surface of the anvil cannot send out heat fast enough to overcome the cooling power applied to the anvil. It is often troublesome to harden a certain portion of a hammer, but if an icicle or a bit of ice be presented to the troublesome spot it readily hardens.

But there is a much better way of dressing up worn anvils, *i. e.*, by grinding. Nearly every large city contains grinding works with facility for this kind of work, and it is only a matter of sending the anvil away for two or three days, and then "pay the bill," which will be a moderate one, much less than that for softening, planing and re-tempering the anvil. If there should be no anvil grinding facilities in town, it would be a good investment to put in a machine for that purpose. A machine is easily rigged up to do the work and it will pay.

James F. Hobart.

Tapered Connecting Rods.

Editor American Machinist:

Professor Thurston calls my attention to the fact that in my remarks on tapered connecting rods, in your issue of August 9th, page 4, I have used a coefficient in his formula which is too large for the purpose, and recommends that 0 1 be used instead of 0.15. Using this value gives dimensions of rods which appear much more reasonable than those calculated with the larger coefficient. The change makes it necessary to re-write the greater part of my remarks on the subject, as follows: the first two paragraphs, with a slight change, being the same as in the original article:

Tapered Connecting Rods.—In modern high speed engines it is customary to make the connecting rods of rectangular instead of circular section, the sides being parallel, and the depth increasing regularly from the crosshead end to the crank pin end. According to Grashof, the bending action on the rod due to its inertia is greatest at $\frac{6}{10}$ the length from the crosshead end, and, according to this theory, that is the point at which the section should be greatest, although in practice the section is made greatest at the crank pin end.

Professor Thurston furnishes the writer with the following rule for tapered connecting rod of rectangular section: Take the section as computed by the formula $d'' = 0.1\sqrt{D L \sqrt{p}} + \frac{3}{4}$ for a circular section, and for a rod $\frac{5}{8}$ the actual length, placing the computed section at $\frac{3}{8}$ the length from the small end, and carrying the taper straight through this fixed section to the large end. This brings the computed section at the surge point and makes it heavier than the rod for which tapered form is not required.

Taking the above formula, multiplying L by $\frac{5}{8}$, and changing it to l in inches, it becomes $d = \frac{1}{50}\sqrt{D l \sqrt{p}} + \frac{3}{4}''$. Taking a rectangular section of the same area as the round section whose diameter is d, and making the depth of the section h = twice the thickness t, we have $.7854\ d^2 = h\ t = 2\ t^2$, whence $t = .627\ d = .0209\sqrt{D l \sqrt{p}} + .47''$, which is the formula for the thickness or distance between the parallel sides of the rod. Making the depth at the crosshead end = 1.5 t, and at $\frac{3}{8}$ the length = 2 t, the equivalent depth at the crank end is 2 25 t. Applying the formula to the short stroke engines of our examples, we have

Diam. of cyl., inches	10	30	50
Stroke, inches	12	30	48
Length of connecting rod	30	75	120
Thickness, $t = .0209\sqrt{D l \sqrt{p}} + .47$ =	1.61	3.60	5 50
Depth at crosshead end 1 5 t =	2 42	5.41	8.26
Depth at crank end 2¼ t =	3.62	8.11	12 38

The thicknesses t, found by the formula $t = .0209\sqrt{D l \sqrt{p}} + .47$, agree closely with the more simple formula $t = .01\ D\sqrt{p} + .60''$, the thicknesses calculated by this formula being respectively 1 6, 3.6, and 5.6 inches. Wm. Kent.

Accurate Hole Locating.

By Oberlin Smith.

It was, I believe, Sydney Smith who spoke of "those confounded ancients who were always stealing our ideas." I must confess to finding myself in a somewhat similar state of mind several weeks since, after preparing the diagrams below and jotting down this article in outline, when I read the communication of Mr. J. G. Kingsbury on page 6 of the April 12, 1894, issue of the American Machinist. My only comfort is that two men, rather than one, (in addition to all the yet other men unknown) practice a valuable and commonsense method of locating holes in jigs and other accurate constructions.

Seeing that Mr. Kingsbury had described the identical operation which I had in view, I was tempted to retire and destroy my notes, but upon reflection decided that the subject in question was important enough to stand the approximate duplication of a couple of diagrams by our mutual friend the editor—especially as what I have written is a considerable amplification of the other article, and attempts to analyze fully the reasons why the desired accuracy can be attained by the methods in question. I will therefore proceed as originally intended.

Several years ago I had occasion to drill a row of four holes in a bar of steel, perhaps 6 inches by 2 inches by 1 inch in dimensions, all of which should be exactly in a straight line and accurately spaced the same distance apart. This piece of steel was for a gang-die, in which a row of closely fitting and carefully-spaced punches were expected to enter. It was put in the hands of the best workman available, who, with a beautifully polished paraphernalia of straight-edges, squares, dividers, scribers, center-punches, etc., and with an air of scientific superiority which gave full confidence in his ability to conquer such a trifling foe, attempted the impossible feat of laying-out and drilling the holes in question, with the result that might be expected, of increasing the averdupois of the scrap-pile. I then contrived the method described in general in the accompanying diagrams, with the result of the same perfect success which is described by Mr. Kingsbury.

The method, as has already been made known, is to fasten a block of metal A to a flat and true-running lathe face-plate F (see Figs. 5, 6 and 7), the distance D of one of its working surfaces a from the axis of the lathe spindle being the distance desired from one edge of the work W to the axis of that hole to be drilled, which is furthest from said edge. The block A has a projecting tail having a working surface b, which is placed at the distance D' from the lathe axis, this being the distance of the furthest hole axis from the right end of W. When W is clamped in position, as in Fig. 5, the first hole therein is roughly drilled from the dead center, and is then "tooled out" to the exact size required, as measured by some standard gauge. Should it run untrue after drilling, several cuts must, of course, be taken through it to eliminate non uniform springing of the boring tool.

This piece of work W, which is shown also separately in Fig. 2, now has the hole which is at the intersection with the lines t and z accurately located. It is obvious that the next hole, in the line u, will also be in the right place if W is slid to the left, and a block E inserted against b, as in Fig. 6, the width of said block being accurately gauged by a micrometer gauge, or otherwise, to the desired distance $t\ u$. In like manner, the hole at v is equally spaced by inserting another block F, as in Fig. 7, of the same size as E, or unequally by a block of different width, if desired.

It is evident that only two holes, as in Fig. 1, or a group of different sized holes, as in Fig. 3, or holes lying different distances from the edge a', as in Fig. 4, may with equal facility be produced. In the latter case blocking is, of course, placed between a' and a, this not being shown in the diagrams. In general, all this is, of course, only carrying out the mathematical principle of two co-ordinates at right angles to each other, these being represented respectively by the distances D and D', or the same as diminished in length by the insertion of blocks E, F, etc.

In practice, it is sometimes easier to divide the stationary block A into two separate ones, as A' and B', Fig. 8; or in some cases, as a matter of construction, the surface b is obtained by inserting a flatted pin in A, as in Fig. 9, two views being shown.

To some minds the question will at once arise, why are co ordinates thus obtained vastly more accurate in length than by the old-fashioned method of measuring with dividers, etc. In the answer to this query lies the pith of this whole article, and also the text for very many operations in machine work, which are now done slowly and inaccurately in spite of the very best workmanship, even if assisted, as is sometimes the case, by the use of a magnifying glass. The essential difference between the two methods is that in one case distances are obtained by a series of *contacts* and in the other by a mere *viewing* of lines. In the contact system, the only errors (assuming, of course, that all visible dirt is removed from the working surfaces) lie in the elastic yielding of the metal itself. Thus, the diameter of a shaft or disk can evidently be measured with an ordinary snap gauge, providing said gauge is extremely stiff as against springing open, within a limit of, say, less than .0001 inch, while nobody would attempt to get it within less than several thousandths of an inch were he to lay a steel rule across the end of it and attempt to see whether the centers of the graduation marks on said rule came in line with the respective surfaces bounding the diameter of the cylinder to be measured.

Not only are there, with the most careful workmanship, a considerable number of errors bound to occur in scribing lines upon flat surfaces, both in their parallelism or other angle to each other, in their distance apart and in their distance from given edges, but the width of these lines themselves will not be uniform, and it is difficult to guess at the central imaginary axis of the same. Furthermore, when the lines have been drawn it is almost impossible, except by chance, to locate a prick punch mark centrally with these lines. Still further is it also impossible to start a drill centrally with a circumscribed circle struck from the prick-punch mark aforesaid, as said circle must lie a little outside of the drilled hole itself, and there is only the eye to judge as to whether the annular space between is of uniform width, even if the line has not been pushed outward unevenly, along with some of the metal underneath it, by the pressure of the drill, which in many cases actually raises the surface and forms a perceptible burr. Still further again, if the drill is started reasonably true it will soon creep sidewise owing to non homogeneity in the metal and other causes, so that the average hole will not be in the same location as was the initial depression from which it started.

In the method of drilling in question, we not only have the advantage of contact measurements, but of being able to use the same principle in locating the hole exactly coincident with the lathe spindle's axis, there being at all times the contact with the fixed tool, at a given distance from the axis, with some element of the cylinder which is being produced.

In regard to the practical method of locating the block A at a desired distance from the lathe axis C, it is evident that this may be accurately done by measuring the diameter, with a micrometer or other gauge, of an ordinary lathe center or other projecting cylindrical object, as shown at C, in Fig. 10, seeing, of course, that said projection runs true—by the contact of a tool or other stationary object against it. The measurement d, from the side of this center C to the surface a, can be determined purely by contact, inserting a standard male gauge, or other "micrometered" object, between the same at the point d. Another method is to slip a truly turned cylindrical bushing or ring, as indicated by the dotted line R, Fig. 10, over the center C, allowing its side to touch a. In this case the required distance is, of course, the radius of R, while in the former it was the radius of C plus d.

In making the general statement that contact measurements are almost infinitely more accurate than what we term visual measurements, I speak only of the same as practiced in machine shops with the tools at present available, supplemented, perhaps, by an ordinary hand glass, magnifying a few diameters. It would not, however, be correct to make this statement broadly, as it is well known that some of the most profoundly delicate astronomical observations are made by sight-reading of verniers and other graduated devices. It must be remembered, however, that these graduations are usually placed upon circles of as large a diameter as possible to reduce the errors, and that they are read with accurate microscopes of comparatively high power. The same general system, as is doubtless known to many of my readers, has been used in combination with certain contact measurements in the *comparators* which are now employed for comparing standard distances in originating accurate gauges, etc. This, however, is a superior kind of machine work which is not likely to come into ordinary shop use. In general, the method herein described will be found useful for a great deal of accurate work in originating jigs, etc., where more convenient means have not been especially devised.

I have for a long time had in mind a universal drilling jig with two micrometer screws, at right angles to each other, governing a locating block in which could be inserted various sizes of standard bushings to guide the drill, and finally the finishing reamer over any given spot upon the work which would obviously be determined in relation to certain starting points by the two co-ordinates measured by the respective screws. Circular as well as rectangular work should be provided for by a supplementary rotating block having its axis of rotation controlled by the screws, and being indexed to move through any desired angle of its whole arc of revolution.

This tool would be somewhat expensive, and would, no doubt, require considerable thought, in designing, to cover the ground properly. It is as yet with me only an ideal, although, very possibly, it may have become a practical entity somewhere else. If so, it is to be hoped that the facts regarding it may be made known to the public through so valuable a medium as the columns of the American Machinist. Could such a device be purchased in open market our machine shops would begin an era of accurate hole locating which would be almost as much better than the usual crude methods as they (the usual ones) are better than the ballistic system—which consists of marking out a group of holes upon the surface of a piece of work by firing a shotgun at it.

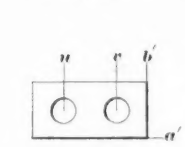


Fig. 1

Fig. 2

Fig. 3

Fig. 4

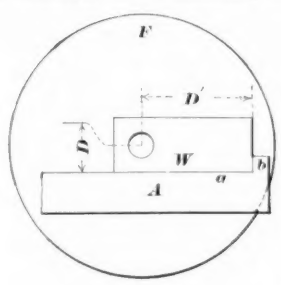


Fig. 5

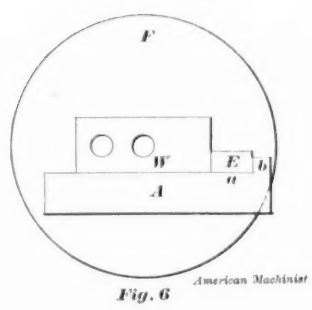


Fig. 6

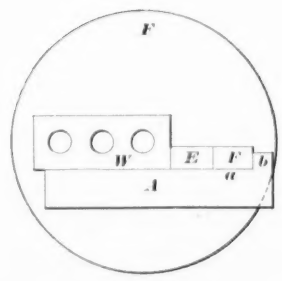


Fig. 7

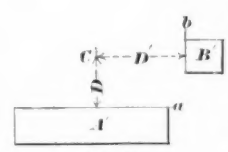


Fig. 8

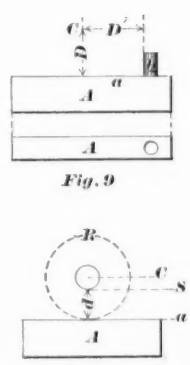


Fig. 9

Fig. 10

Fig. 7

Accurate Hole Locating.

Four Tons of Test Bars.

The Detroit Stove Works, under the supervision of their superintendent, Mr. Lafayette Crowley, has just completed for the Committee on Standard Tests of the American Society of Mechanical Engineers, the castings of twelve series of test bars; each series comprises in duplicate every size of test bar that has ever been used, ranging from half an inch to four inches square, and for transverse, tensile or compression test. A separate heat was made for each series in a cupola especially arranged for this work, and the silicon was made to vary from 1 to 3½ per cent. Six of the series were made from Iroquois (coke) pig, and six from Henkle (charcoal) pig-iron.

As the member of the committee who has this matter in charge is Mr. W. J. Keep, we shall expect some valuable conclusions regarding the relative strength, shrinkage and chill due to change in composition and size of the casting.

The Mechanical World is hereby notified that to reproduce in its columns a complete article with illustrations taken from our columns, crediting it merely to "an American contemporary" is not satisfactory to us. There is only one way to properly reprint valuable articles, and that is to give full and definite credit for them.

What is said to be the largest passenger train ever pulled in this country ran from Jacksonville, Florida, to St. Augustine over the Jacksonville, St. Augustine & Indian River Railroad.

It was a regular train and carried on the 19th inst. over 1,600 people, in 25 coaches, with one baggage car. The train was pulled by one Schenectady engine, and the distance, 38 miles, was made in slightly over an hour.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
203 BROADWAY, NEW YORK.

PUBLISHED WEEKLY AT
203 Broadway, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
J. G. A. MEYER, } Associates.
FRED J. MILLER, }

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

Subscription.

$3.00 a year in advance, postage prepaid, in the United States, Canada, and Mexico.
$4.00 a year to Other Countries, postage prepaid

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.
No Commission allowed to Advertising Agents.

The American News Company,
Publishers' Agents, New York.
DEALERS SUPPLIED BY
The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Buffalo News Co., Buffalo, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, New York.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N. Y.
The Wisconsin News Company, Milwaukee, Wis.

The International News Company,
BREAM'S BLDG'S, Chancery Lane, LONDON, E. C., ENG., or Stefanstrasse 18, LEIPZIG, GERMANY, will receive subscriptions for the AMERICAN MACHINIST, at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.

Subscriptions received in Paris, France, by E. TERQUEM, 31 Boulevard Hausmann, at 21 francs per annum, postpaid.

Subscriptions received in Australia by W. WILLIAMS, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, AUGUST 30, 1894.

CONTENTS.

PAGE.

Machine Shop Milling Practice. By Horace L. Arnold..... 1, 2
The Thermal Relations of Air and Water. By Frank Richards..... 2
Calculating Weights for Estimates. By Joseph Horner..... 2, 3, 4
Railroads and Madness..... 4
Intelligence Conveyed by Drawings. By B. F. Spalding..... 4, 5
Letters from Practical Men: Piecework. By J. T. G ...Notes on Steam Boilers. By Tom Thrall...."Fraudulent Testing." By "C." Gas Engine for Electric Lighting. By W. E. Crane ..Care of Wet Tools—Removing Water from Watches and Small Machines—Grinding an Anvil. By James F. Hobart ..Tapered Connecting Rods. By Wm. Kent.. 5, 6
Accurate Hole Locating. By Oberlin Smith... 7
Four Tons of Test Bars..... 7
Emigration and Immigration..... 8
Jealousy of Wealth..... 8
The Perfected Pneumatic Dynamite Gun..... 8
Questions and Answers..... 9
Plans and Methods Necessary for Obtaining Comparative Physical Tests of Cast Iron. By Thos. D. West..... 9, 10, 11, 12
Manufactures..... 12, 13
Machinists' Supplies and Iron..... 13, 14

Emigration and Immigration.

The exodus of workmen of foreign birth from this country appears to be unabated, in fact, to increase in volume. In the early days of the AMERICAN MACHINIST it ventured the opinion that the matter of inducing immigration to this country had already been quite overdone, but enthusiasts told the people, who readily believed them, that every emigrant who could be induced to come here represented, in his person, a good round cash value, and so it came about that corporations and great companies imported the very lowest classes from Europe, native born workmen and those that had come here for citizenship, standing but a sorry chance of making an honest and respectable living in competition with those who were content to live off the contents of ash barrels and lodge like beasts. The country could, to its advantage, in every way, spare a good many thousand such workmen, but the trouble is that unfair competition is driving back a good many honest, intelligent men whose presence is in every way desirable. If it were only those of the imported type who were going back it would be a matter for congratulation. They would be well gotten rid of by paying their passages home.

Of course, one of the principal reasons for the present exodus is scarcity of work here and the high cost of living. It is not a desirable place in which to be idle. In one instance, with which we are acquainted, there is a family of four, the husband being a carpenter. Scarcely expecting to find work this fall and winter he estimates that it will be a saving in money for them all to return to Sweden and remain till spring, even though he gets no work there; then, if there are fair prospects of work here, coming back again. That is, that the cost of the passage both ways will be more than balanced by the cheaper cost of living there.

But putting aside the question of dull times, which is substantially universal throughout the world, in the best of times it has been evident for some years that there were more men here than there was work for. The great army of tramps has been steadily increasing, and not all of them, by any means, began their tramping from choice. Necessity has had a good deal to do with it. This condition of affairs has been, to a great extent, brought about, not by the natural law of emigration, but by the importation of the worst part of European labor, for purely selfish motives. It has been carried to such an extent as to be absolutely a menace to the country.

It is natural for one to believe, considering what he hears of everyday occurrences, that there was never a time in the history of this country when deliberate cheating in business matters was so common as now. Taking up a daily paper recently on a single page there were references to no less than four cases of fraud, in two of which the government suffered, and in two the people, directly, were the victims. We are inclined, however, to the belief that scamping work is no more common now than it always has been, at least has been for some years. A good many remember, some from personal experience, the shoddy blankets and overcoats of the late war, which were about as bad as anything could be. Fraud and cheating are no more common, but more of this kind of work is brought to light; the newspapers give the news more thoroughly and completely than they did a few years ago. But be this as it may there is a good deal of dishonest work going on, and the government is especially made to suffer.

In one case, not referred to above, viz., that of the Benjamin Atha and Illingwood Company, it looks now as if the government was going too fast; perhaps not, but it looks that way. The members of this firm have been arrested in criminal proceedings, being charged with conspiracy to defraud the United States. If the matter is as we hear it, it is all about some $200 worth of steel castings, that is, four pistons. These had been plugged where there were blow holes. Complaint was made of these four castings and others were sent to replace them, and here it might be supposed the matter would have ended. It certainly would if between business houses. It is hardly to be supposed that there was an intention to defraud, as the plugging would be sure to be detected in machining the work. The government has had to do with some large frauds for which no one was arrested, and we believe that this is a case of too much zeal.

Jealousy of Wealth.

A magazine writer, who writes upon "The Prevailing Jealousy of Wealth," undertakes to show that the possession of wealth is satisfactory evidence that its possessor has earned it, or has created values far in excess of what he has himself retained, an argument which, it is needless to say, would hardly avail a pickpocket in a police court. The writer in question declares that Jay Gould was a benefactor, and *created* far more wealth than he amassed for himself, which will be news to most of those who have studied the career of the greatest railroad wrecker of history, and who regard him as chiefly a wrecker and manipulator, and not at all as a creator of anything except barely legal devices by which a few were enabled to rob the many. Jay Gould did not create the Erie Railroad, but stole it from those who did create it, and it is to day struggling almost hopelessly under a burden of obligations, which, of course, have a value for those who hold them, but are not wealth any more than the power of the ancient Rhine robbers to tax the traffic of the river was wealth.

The fact is that there is no "prevailing jealousy of wealth" that is worth talking about. There is, however, a very considerable and a growing disposition to criticise the acquisition of great wealth by dishonorable means—means which barely keep their users out of prison, and which everybody knows should send them there. This antipathy to dishonestly gained wealth is wholesome, and we sincerely hope it will increase until it will become impossible for men to carry on such operations as were carried on by Gould, and are being carried on to-day by hundreds of other men who justify themselves in any rascality by which they can manage to amass wealth, so long as skillful lawyers can steer them clear of prisons.

Any one who thinks of the matter at all can recall the names of dozens of wealthy men whom practically no one thinks of condemning for being wealthy—simply because they get wealth honestly, and are good and useful citizens. There is no "prevailing jealousy" of such men, and they are really injured and insulted by being classed with manipulators, schemers, purchasers of legislation, etc., and by an attempted defense of them on that basis. Honestly gained and honestly used wealth is respected and is secure; its greatest menace, perhaps, being such indiscriminating and short-sighted defenders, who would place a Cooper or a Corliss in the same class with a Gould, or a Wall street gambler. There is a defense which is nothing but an unjust accusation.

We think, upon a little consideration, it will be evident to most sober minded, thinking people, that the word "anarchist" is being used quite too much and quite too loosely in this country. Its use in the way it is being employed is very likely to do harm. A few thousand people, more or less, in a State of the Union declare their convictions that a governor was elected by fraud and that they do not feel under obligations to support his administration, and it is telegraphed to the press of the country that these men are anarchists. Let there be a strike of workingmen, and some little rioting, generally almost entirely by outsiders, and the word anarchists is freely applied to the strikers. At the present time the people of this country, and especially the honest workingmen, have an intense hatred of everything tending towards anarchy. They hate the name, and it is not wise to make a too familiar and altogether senseless use of it. There is an old adage that couples together the "game" and the "name" that is worth heeding in this as well as in other things. Let all the community unite in calling an honest man a thief, let it be spread in the papers, preached from the pulpit and thundered from the platform, and there is great danger that he will begin to steal. He may begin to steal and scarcely be the one most to blame at that; in fact he has not much else to do than steal. It is altogether best to call things by their right names.

An increasing interest in scientific matters is, we should think, shown by the fact that the daily papers of New York have given the meeting in Brooklyn of the American Society for the Advancement of Science more attention by great odds than they have ever before given any scientific or engineering meeting. To be sure, they have not done much in the way of reporting the proceedings, or presenting the discussions, but they have done more than usual in these respects and have given considerable space in a general way to the sessions. It would not be fair, perhaps, to say this was due to the fact that there was not very much going on in politics and space had to be filled. It would be more charitable, and probably true, to conclude that they are finding out that their readers are interested in other things than who is to be the next governor of this or the other State, or even the next mayor of New York City; that a good many of them are more interested in solid facts of some importance than they are in the latest scandal—mostly a lie. It is a good sign to see the daily papers giving some attention to matters of science.

There are some curious things about the regulations of the Pilot Board, or at least in the way they are carried out. For example, a vessel about to enter New York harbor was hailed by a pilot who demanded $6 25 more than the lowest fee, on account of the water drawn by the vessel; that would be the fee for off shore pilotage. The captain refused to pay this and took his vessel in himself. Then the pilot presented a bill for regular pilotage (without the $6 25 addition), and rather than have his vessel libelled, the captain paid it and appealed to the board, who sustained the pilot. Just why the pilot should be sustained in collecting his regular fee for doing nothing when he had refused to take the vessel in without an addition to it is what is likely to bother landsmen. If he had at first demanded only the fee he finally collected the matter would be simple enough.

The Perfected Pneumatic Dynamite Gun.

Some recent tests of the pneumatic dynamite guns made for coast defense and mounted at Sandy Hook showed a remarkable efficiency in every respect, and it seems to be conclusively shown that it would be an impossibility for any war vessel to enter the port of New York so long as these guns are in position and it is desired to keep it from entering.

One test resulted in throwing eight shells loaded with 200 pounds of nitrogelatin a distance of about two miles and dropping them all into the water within a space 30 by 120 feet; the requirements of the contract being that only 60 per cent. of the shells should be dropped within an area 90 by 380 feet. The shells were timed to explode two seconds after striking the water and did this in every instance.

An English mechanical contemporary publishes a long article giving directions for the care of agricultural engines. We don't know how it may be in England, but are quite certain that the publication of such an article in a mechanical journal in this country would result in no benefit whatever, chiefly because those who have charge of such en-

gines do not read mechanical papers and have no inclination to give agricultural engines any care whatever, it being thought evidently that they require no care so long as they continue to turn over when the throttle valve is opened.

It occurs to us in this connection that we are not hearing of the usual number of explosions of boilers of threshing engines. The annual killing off of our rural population by this means ought, according to precedent, to be in full swing within a week or two.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(407) C. H. D., Washington, D. C., asks: Please inform me, if possible, where I can obtain a spring motor which can be placed in a circular case about 6 inches diameter and 4 inches thick, and which will run about 5 hours with power enough to run a machine similar to the Edison phonograph? *A.*—We do not know. Perhaps some of our readers can furnish the information.

(408) A. P. A., New Orleans, La., writes: Please inform me how to lay out by triangulation the sheets of three pipes branching into one. *A.*—Examples in laying patterns for sheet metal work by triangulation are given in our issues of January 25th, March 1st, and April 19th, current volume. The principles of laying out a Y pipe, given in our issue of March 1st, are applicable to your problem. We would, however, advise you to read all the papers referred to.

(409) E. S. B., Elizabeth, N. J., asks: Where can I obtain a small pocket arithmetic in which the rules of addition, subtraction and multiplication are given, also rule for calculating the areas of circles, triangles, weight of various substances, etc., I mean a book for mechanics? *A.*—We do not know of any pocket-book that contains the fundamental rules of arithmetic; the assumption is that those having use for a pocket book understand how to add, subtract, multiply and divide. There are a great many pocket books published containing the other information you mention.

(410) C. W. L., ——, writes: Please say whether or not increasing the speed increases friction. *A.*—It may or may not, according to circumstances. If we have a journal running at a moderate speed, well lubricated, and with a light load, we may, ordinarily, increase its speed without changing the coefficient of friction; in which case the force required to overcome friction will remain the same, but the moment of the force, or in other words, the power required to overcome the friction of the journal will be increased in proportion to the increase of speed, simply because it is the same force acting through a greater distance per unit of time. But under other conditions, such as where a journal is already running at as high speed as it ought to run with the given load and conditions, lubrication, etc., an increase of speed may increase the coefficient of friction, either by preventing thorough lubrication or by the development of heat faster than it can be conveyed away by surrounding parts or by the atmosphere. The increase of temperature so caused may thin the lubricant or otherwise cause an increase of the coefficient of friction. Under other conditions an increase of speed may and sometimes does decrease the coefficient of friction.

(411) S. K., Mt. Carmel, Ill., writes: I have a 4 horse power boiler and engine which I have used satisfactorily for over a year for various farm purposes. Quite recently, however, when using it to its full capacity for grinding feed the water in the gauge will rise above the actual level and water will go through the cylinder and down the tubes, putting the fire out. I use good water, mostly from a cistern. I have blowed off a number of times, and used boiler compounds, but still it foams. About three months ago I used about one half gallon of oil, filling the boiler full of water and letting it run out slowly. I have looked in the hand holes and there appears to be no oil left in the boiler, and it looks clean. It works satisfactorily when engine is loaded light. What can I do for it? *A.*—We cannot form much of an opinion, knowing nothing of the construction of the boiler. It seems very probable that you are crowding the boiler harder than it will stand, which causes it to prime, or you may be carrying the water too high. The only thing we can advise from the little we know of the conditions is that you put three to four pounds of soda ash, or common soda of commerce, in the boiler, fill as usual with water, keep up steam for about 24 hours, then blow off and try again. If you find this helps matters, repeat in two or three days. If this does no good there is some trouble that a competent engineer should be called in to decide. After using the soda remove the hand hole plates and look for dirt.

(412) X. Y., ——, asks: Having a reamer 30″ long, and with a taper of $\frac{1}{8}$″ per foot to be fluted with a 12°x40° cutter, would you elevate the small end of reamer $\frac{5}{32}$″ to make the cutting edges even thickness? *A.*—The amount of elevation necessary to give uniform width of "land" will be influenced by one condition not named by you, and that is the number of teeth in the reamer, and we cannot assume a number because you have not given the size of the reamer. Whether the width of land should be equal from end to end on a taper reamer is not a settled question, but is largely a matter of preference and circumstances. Unless there is considerable taper, and the small end of reamer is very much smaller than the large end, it is probably better to make the width equal. We do not think the cutter described is a good form for reamers, and would prefer one with a small angle on one side, say, about 5°, and with the other curved to give a good form of flute. An idea of the proper shape can be gained from an inspection of the reamers made by well-known firms who manufacture them for others. The computation necessary to determine the proper elevation for even width of land would be somewhat complicated, and it is more practical to make a trial cut or two until the proper setting is obtained, though this can, of course, be done by sinking the cutter in at each end in the case of a long reamer, or, it may be determined from a diagram in a manner which will readily suggest itself.

(413) L. E. W., Louisville, Ky., writes: I have a horizontal tubular boiler in use about one year. It was sold to me for 100 horse power: 1 How much water should this boiler evaporate to be 100 horse-power? The steam pressure varies between 60 and 80 pounds. *A.*—Assuming the average pressure to be 70 pounds, the boiler should evaporate 3,000 pounds of water per hour, with feed at about ordinary temperature. 2 When a boiler is sold to evaporate a given amount of water per hour, what is understood and how is the matter come at? *A.*—It would be understood that the evaporation should be from and at 212 degrees. That is the same as if the water were supplied to the boiler at 212 degrees and the steam allowed to pass to the atmosphere without hindrance, the location being where water boils at 212 degrees. In practice the water is supplied at any temperature and any desired pressure is maintained. Then the heat required to raise the water from the temperature of the feed to 212 degrees, and the extra heat required to vaporize it under the higher pressure are found by consulting steam tables, and in this way the evaporation that would have been from and at 212 degrees is calculated. 3. How can I tell whether or not the steam is dry? *A.*—The only way you can determine this, with certainty, is to get an engineer, used to such matters, to make a calorimeter test for you. If you place a small cock—say $\frac{1}{4}$ inch—in the steam pipe, close to the boiler, an experienced engineer can judge very closely by opening it. 4. From such tests as my engineer has been able to make, weighing his coal and water used for ten hours, he calculates that the boiler evaporates 9$\frac{1}{2}$ pounds of water per pound of good coal used. Now I am approached by the agent for a patent boiler, who agrees to sell me a boiler that will evaporate 12$\frac{1}{2}$ pounds of water, and on this basis he says it will pay me to throw out my old boiler and put in his. The present boiler works satisfactorily in every way. My engineer quotes "Let well enough alone" to me. What do you think of it? *A.*—If your boiler is evaporating 9$\frac{1}{2}$ pounds of water per pound of coal, and is as you say satisfactory in other respects, we think your engineer is a sensible man. We do not believe there is a boiler in the United States that is evaporating 12$\frac{1}{2}$ pounds of water per pound of coal. We have sometimes read of such performance, but never saw anything approaching it very closely. 5. Can I save anything by burning a cheap quality of coal, and if so what will the saving be? *A.*—If your boiler will make all the steam you want with the cheap coal you may probably effect some saving by using it. The only way to determine this is by a trial of a week or two. We cannot say what the saving, if any, will be. "Cheap coal" is decidedly indefinite, and we could not tell if we knew all about the difference in price. 6 My engine is quite old and my engineer says that it does not cut off till the end of the stroke and chokes up in exhausting. Can you suggest any remedy? *A.*—The best remedy we can suggest is to buy a new modern engine.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gears, Lex'n, Phila., Cleve'd. See page 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

"National" Lathe Chucks. Best made, page 15.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work. Ferracute Machine Company, Bridgeton, N. J.

Air Compressors for every possible duty. Clayton Air Compressor Works, 26 Cortlandt street, N. Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

Grinders' Supplies—Emery, emery wheels, grinding machines, knife powders and sharpeners, paste and liquid polish, whetstones, etc., etc.; quick process and large stock. Customers annoyed by the delays due to long processes and small stock can get goods in a hurry by buying of The Tanite Co., N.Y. City, Cincinnati, O., and Stroudsburg, Pa.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

Plans and Methods Necessary for Obtaining Comparative Physical Tests of Cast-iron.

BY THOS. D. WEST.

In considering the subject of testing cast-iron, two factors are first to be recognized. One is, the method for molding and casting; the other, the form and size of test bars. The first factor comprises arrangement of the mold, manner of gating, mode of pouring, means for obtaining contraction, shrinkage and chill; also the fluidity of the metal. The second factor relates to the form and size of a test bar most favorable to obtain a relative comparison of cast-iron.

Experience in all branches of founding, as a manager or molder, are necessary before one can formulate a system which can be practical for a universal comparative test of the strength, contraction, shrinkage, chill and fluidity of cast iron. Especially in the heavy work branches of founding is experience essential, for in such, we are confronted with elements in the working of cast iron having cause and effect which experience in light work cannot afford us any knowledge of.

In view of the writer's experience in light and heavy founding, he has made bold to here present an original plan for obtaining a universal comparison of the physical properties of cast-iron. To state briefly my objections to the system proposed by Mr. Keep and illustrated in AMERICAN MACHINIST issues of January 5, 12, 19; February 9, 1893: I do not think a test bar of square section is right. The contraction is obtained by having bars cast inside of iron yokes or flask ends which will not permit of a free expansion of the metal at the moment of solidification. The chill is generally derived by a method which pulls the test bar away from the chill a few moments after the metal has solidified, instead of having the chill and test bar casting remain in close contact until all is cold enough to handle. Then, again, the test bars are all cast flat, a plan by which the least variation in dampness of the mold, degree of its hardness and fluidity of the metal can have the most radical effect in changing results.

This system, which the writer herein presents, embodies a long experience and study chiefly in heavy foundry work, both as a molder, a foreman and a proprietor, thus enabling an attainment of an experience in the principle of founding most valuable in aiding him to speak with confidence of the work he would now present for unbiased, logical consideration.

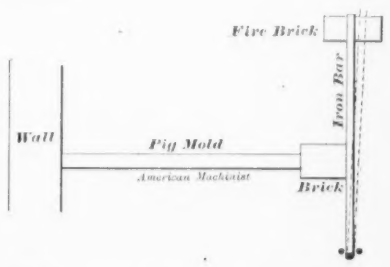
My reason for adopting a round test bar in preference to a square one, has been discussed in a paper presented before the Western Foundrymen's Association, June 16, 1894. My reason for adopting the methods used for obtaining the contraction and chill, which differ so radically from present practice, we will now discuss before proceeding to other subjects pertaining to this system.

It is but a few years back that the founder could find a practical illustration of metal at the moment of solidification expanding. To show the clear, convincing manner in which this was demonstrated, and the vital importance of such in arranging to obtain the natural contraction and strength of cast-iron, we here publish an extract taken from *The National Car and Locomotive Builder*, by John R Whitney, of Philadelphia, Pa., which is as follows:

"In my impromptu remarks before the N. Y. R. R. Club, I could probably have made my meaning clearer, if I had stopped to explain that the 'moment of solidification' is the moment when any portion of a casting becomes solid. At that moment that portion of the casting expands, and it is probable that contraction of the whole casting, under ordinary circumstances, does not become apparent until the expansive force is spent. In confirmation of this statement I beg leave to call attention to the following facts:

"1. Several years ago I had occasion to meet this question practically. To test the matter, I prepared two molds of exactly the same size in every particular. One mold was filled with iron at a white heat, directly from the cupola. The ladle was then allowed to stand until the rest of the iron had cooled down so as to only be just fluid enough to run freely, when the second mold was filled. Both were left undisturbed in the sand until they were perfectly cold. Then they were cleaned and carefully measured. They were found to be exactly of the same dimensions in every particular. The contraction of each from the size of the pattern was exactly twenty-five one-hundredths of an inch in 12 inches.

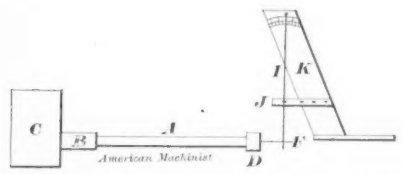
"2. On another occasion, an ordinary pig about eight feet long was molded in open sand, so that one end of the mold was closed by a solid brick wall and the other end by a fire brick, free to move in the sand. Against this fire brick a bar of iron, 6 feet long and 1$\frac{1}{2}$ inches square was laid, one end being pinned to the ground and the other resting on a fire brick. The fire brick connection with the mold was at about two feet from the pivoted end, as shown in the annexed diagram.



"This apparatus was prepared impromptu, and, as will be seen, was exceedingly crude. I expected no satisfactory results. On pouring the pig, however, every one was surprised after a few minutes to see the bar of iron gradually move on the

supporting fire brick, as indicated by the dotted lines, until it lay one quarter of an inch from its original position.

"On a more recent occasion, the following experiment was made with an apparatus more carefully prepared, as shown below.



A pattern, *A*, 4 feet long, 3⅞ inches deep and 2¾ inches wide, was molded in open sand; one end of the mold being closed by fire brick *B*, and the other end by a piece of gas carbon, *D*, which was suitably connected with a small battery and galvanometer. The fire brick *B* rested at one end against a block of iron, *C*, weighing about half a ton. The gas carbon block *D* was carefully secured in the sand, so that the weight of iron in the mold should not be sufficient to move it. The stand *K*, bearing an arm *J*, on which the pointer *I* was delicately pivoted, was then adjusted so that the needle *F* should press against the gas carbon *D*, and the pointer stand at zero on the scale. The long arm of the pointer was 24 inches, and the short one 6 inches long, or as 1 to 4. The scale was graduated to $\frac{1}{16}$ of an inch.

"*A*, casting; *B*, fire brick; *C*, weight; *D*, gas carbon block; *K*, stand; *I*, pointer; *J*, supporting arm; *F*, adjusting needle."

The mold was filled with very fluid hot iron in 17 seconds, and then the following results were carefully noted:

For more than 1 minute after the mold was filled pointer stood at zero.

At 1 minute 30 seconds after the mold was filled it moved $\frac{1}{16}$.

At 1 minute 50 seconds after the mold was filled had moved $\frac{1}{8}$.

At 3 minutes 10 seconds after the mold was filled had moved $\frac{1}{4}$.

At 5 minutes 20 seconds after the mold was filled had moved $\frac{3}{8}$.

At 8 minutes 5 seconds after the mold was filled had moved $\frac{7}{16}$.

At 11 minutes 30 seconds after the mold was filled had moved $\frac{15}{32}$.

At 12 minutes 5 seconds after the mold was filled had moved $\frac{1}{2}$.

"From that time the pointer stood perfectly still at $\frac{1}{2}$ inch, until 25 minutes 15 seconds after the mold was filled, when the galvanometer showed that contact with the gas carbon was broken and contraction had begun."

"I have made several other equally convincing experiments, but the length of this article forbids that they should be repeated here."

"5. Long before these experiments were instituted the fact that iron follows essentially the same law as water in solidifying was well known and published. I need cite only two authorities, Prof. Edward Turner in his 'Elements of Chemistry,' published in Philadelphia in 1835, by Desilver, Thomas & Co., says, page 20, 'Water is not the only liquid which expands under the reduction of temperature, as the same effect has been observed in a few others which assume a highly crystalline structure in becoming solid; fused iron, antimony, zinc and bismuth are examples of it.' Prof. Thomas Graham, also, in his 'Elements of Chemistry,' published in Philadelphia in 1843, by Lee & Blanchard, says, page 385, 'Iron expands in becoming solid, and therefore takes the impression of a mold with exactness.'"

"6. As the observation of this law was the basis upon which my experiments leading to the successful development of the contracting chill for cast-iron car wheels was based, I am persuaded it will lead to many other practical results of great importance. This is my apology for trespassing upon your space and calling special attention to the matter."

The above illustration of expansion at the moment of solidification by John R. Whitney, I can verify from experiments which I have conducted myself. They all prove that casting test bars between yokes or rigid flask ends is wrong, as they do not permit the test bars to have a natural action, and while we are unable with our present knowledge to say to what grave extent such an action would be injurious in causing erratic results in testing for strength or contraction, it is sufficient to know that it will not permit the free action which the nature of iron demands, and in designing the system here presented much study was given this point in order that full freedom could be allowed. How this is obtained will be explained further on.

The next point which we will now discuss is the methods generally used for obtaining the chill of an iron by means of test bars. To know what an iron will chill it is necessary that the chill and casting should remain in close contact until both are cold to handle. Here we find present systems again wrong, as the test bars pull away from the chill the moment they commence to contract. To show the effect of such I will quote another extract from an article in *The National Car and Locomotive Builder*, on "The Cause of Uneven Chilling."

"Until recently the makers of cast iron car wheels have been puzzled by the fact that the chilling was invariably deeper on one side of the wheel than on the other, and though recognizing the fact have regarded the reason therefor as impossible of solution. Some experiments a short time ago made the whole thing as clear as daylight. A flat chilling surface was made, and so placed in the flask that it could readily be moved after the iron had been poured. Repeated tests showed that removing the chill, as soon as the iron had solidified enough to stand, lessened the depth of the chilled iron, and that this depth was dependent upon the length of time in which the chill was allowed to remain in contact with the cooling mass. I will say that on this point I have also tried experiments and can verify the truth of the above logic. In order that the test bar should remain in close contact to give a full showing of the chilling qualities of an iron in the system here presented I have provided a very simple arrangement which can be seen by referring to the portion further on treating this."

Another important element to be ascertained in casting test bars is the fluidity of the metal filling the mold at the moment it is poured. Late experiments by the writer and others go to fully prove that the degree of fluidity of metal at the time a mold is poured has much to do with affecting results in the strength of test bars. Appreciating this fact to be one that should not be ignored I have provided means whereby such information can be obtained. I know of no one having designed provision for obtaining this information.

We will now discuss a factor which heretofore has not been noted and no system has been able to record, and that is the shrinkage of iron, which is often as important to be known as the contraction of iron. In a recent paper I called attention to the misuse of these terms, by most all calling contraction, shrinkage, when their relations are as different as is possible for two elements to be, and while to a great degree they are caused by like causes, still it is often as important to understand the one as the other, for if a founder is shown his iron has high shrinkage, he is well forewarned to provide against its evil and has something to assist him to seriously impress the molder with the importance of providing good "feeding heads," etc., so as to insure good, solid castings. The system here advanced by a novel, simple plan provides means to measure the shrinkage, as will also be seen further on.

Having explained the manner in which my study and experience would demonstrate that the physical properties should be recorded in testing cast-iron, we will now proceed to the original plan which the writer has devised for molding and casting test bars to obtain the strength, contraction, shrinkage, chill and fluidity of an iron. We will first take note of the form and size of the test bar which is recommended as practical to give comparative tests of the above physical properties of cast iron.

The size and form of a test bar which I would recommend as practical for obtaining comparative physical tests of cast-iron in the rough and turned is a round bar of an area as near to one inch square as it is practical to make it. This in close figures gives us a bar 1.1284 inches diameter, and is equal to 1.0000372 square inches. In rough figures this is 1⅛ inches diameter, the length of the bar to be about 15 inches. This gives it ample length to rest on supports 12 inches apart when broken for transverse strength, as seen at Fig. 1 (page 11), and by keeping the bar to one end of the 12 inch supports in the groove *X*, it will break so as to leave the longest piece about 8 inches. This would admit obtaining the tensile strength by any who might desire to do so.

In placing a test bar on the end supports for transverse strength, have the notch *X* rest on the supports, as seen in Fig. 1. By following this practice you are always assured of applying the load the same distance from the end cast down, and also by breaking nearest to the end cast down you have more surety of the bar being free from any flaws should conditions in any wise have favored such. Especially with turned bars should this practice be followed, as there is a chance with hard irons of the action of shrinkage causing the metal to not be as solid at the upper end of the swell as at the lower end, and hence in setting the patterns *N* and *N*, Fig. 4, forming the swell *T* on the round test bar, as seen at Fig. 3, they should be set 7½ inches from the lower end of the test bar to the middle of the swell; this is gauged by having a notch cut in the follower board as a mark to set the swell pattern at the same place every time.

Another advantage not yet mentioned which the round test bar affords, is its adaptability for removing the surface which has been radically affected by the walls of the mold; to learn the natural strength of an iron this cannot but be readily seen. The amount which should be turned off a bar can be regulated by the depth of chill. table for which will be given in coming writings.

One using this system will soon discover it will be very rare to obtain a test bar that is not perfectly solid. This in itself is worth an adoption of the system in preference to present practice, for it only needs a review of the remarks after tests to show the comparatively few perfect, sound test bars that are obtained in proportion to the number that are made. Casting test bars on end, when rightly arranged and gated, involves a principle by which many sound castings could not otherwise be obtained. The arrangement of the gating as shown by Fig. 3, can be readily detected by the skilled molder as being such as to aid in insuring clean, solid work. As the metal drops down the runner *F* it falls into a little well *B*, thus leaving metal at the bottom, for metal to drop into until the lower basin *D* is filled. Were there no well *B*, and the first droppings struck a flat, sand face before there could be a body of metal for the downcoming metal to drop into, the sand would cut up and form dross or dirt, which might find way to escape up into the test bars through the gate *E E*. The runner *F*, as shown by Fig. 3, is ⅜ diameter. We could use a runner the same diameter as the test bars, and then use the runner for testing purposes, thus giving three instead of two test bars. I am not advising the necessity of having three test bars for general work; only where exceptional inspection is demanded might the third bar be found useful, for I know that as experience in the use of the round bar cast on end, as here arranged, increases, it will be found to be very rare that one bar would not serve the end as well as three.

The gates *E E* should not be made larger than ¼ inch diameter, as in doing so, they would be difficult to break off, and hence tend to jar the test bars, so as to affect their strength in testing.

After the mold is rammed up, the test bar patterns *H H* and runner *E* are pulled out endways before the cope is lifted off, as illustrated at Fig. 5. The reason for this is to insure round bars showing practically no joints, which is one of the features of this system, as such a method avoids the necessity of any rapping of the pattern before being drawn, and hence, if the mold is rammed fairly solid, the castings need be no larger than the size desired.

Two more new features made practical by this system are elements relating to ramming and evil resulting from damp sand. If we can control these, much is achieved in assisting to remove cause for erratic results in testing. Molds cast on end from a parallel pattern will always be largest at the bottom owing to the head pressure. In making the test bar patterns have them 1.1284 at one end and 1.0884 at the other. In rough figures these patterns would measure 1$\frac{1}{32}$ inches at the large end and 1$\frac{3}{32}$ inches at the small end, and by having a ring at the largest end, as seen at *W*, Fig. 4, the smallest end will always be the down end in molding and in ramming the mold do so to such a degree of hardness as to permit sufficient straining to have the castings come out the same size at the bottom as the top. To do this I would say to the molder, ram fairly hard. A little display of judgment and a few trials will get one accustomed to ram the hardness necessary to attain the same diameter at bottom as top in the resulting test bar castings. Regarding temper of sand, have this so as to not cause trouble from the metal not raising up quietly and laying kindly to the sides of mold when the same is poured, if a green sand mold is used and if a dry sand mold, which the system admits, danger from such a source is then overcome. It is very essential in molding test bars that the manipulation should always be the same as near as possible. To attain this some one intelligent molder should be intrusted with the work as long as he remains in the shop.

We might mention at this point, should any desire to make their test bars in a dry sand mold, they can readily do so, as there is no wood whatsoever connected with the flasks, thus making it practical to place the mold in an oven to be dried. With hard cast iron, malleable and steel, such would be a very acceptable practice, and as I believe the system to be practical for the latter two metals, I would like to learn of its being tried with them. The system admits of all patterns keeping their form and size, and is one that would not permit the molder going very wrong, should he try to do so. Little errors of judgment are not as effective in changing results as with the square bar cast flat. After the patterns are drawn the contraction gauge *O*, Fig. 4, is then set into the molds, as seen at Fig. 2, and the upper contraction tips *M M* are punched with *Z* seen at Fig. 4 (the "chill" forms the lower tips, as seen at *A*, Figs. 2 and 3) as to leave projection on the lower end of the castings, as seen at *A*, Fig. 3. The gauge having been withdrawn, the cope is then closed on and the flask clamped by means of small clamps *L*, Fig. 4, over the projection lugs *P P*, Fig. 6, after which the flask is up-ended, as level as it is practical for the eye to set it, as seen at Fig. 7. These clamps are also used for clamping the cope before it is rammed up, so as to make sure of the joints of the cope and nowel being brought tight together. Likewise, should the follow board and nowel be clamped together before the latter is rammed so as to prevent its raising from the face of the follow board. To accomplish this we have eye hooks on the mold board which can come up and clasp over the bolts *P P*, seen at Fig. 6.

In pouring the molds use a hand ladle having a lip such as will concentrate the stream in a compact flow. Do not have a lip such as to spread the flow all around the pouring runner. After starting to pour keep the runner full, and as the metal is seen raising up within 2 inches of the top then slack off and bring it up to the top so

that the metal in the test bars will not by pressure of the head weight of the dropping metal be but a trifle higher than that in the runner. By this practice the mold will be filled without having a surplus running all over the flask and a fair approximation of the shrinkage be subject to record. The cuts, Fig. 7, show the flask in position as being poured. The test bars should not be shaken out until they are cold to handle.

For fluidity of metal best to pour test bars, I would say as hot as the iron can generally be obtained from the cupola.

We now come to a discussion of recording a new factor affecting the physical qualities of cast-iron. It is now generally known among most progressive foundrymen that the degree of fluidity at which a test bar is poured affects the strength. Many experiments which I have conducted on this point have shown the hottest poured test bars to record the greatest strength; only in one case did I find dull metal to prove the contrary. Outside of Mr. Keep, who found his ½ inch square dull poured bars to give the greatest strength, every one that I have heard of experimenting in this line has agreed with my experience, but as all these results have been recorded from a square test bar I do not lay down the above as a rule to be guided by in all kinds of cast-iron. Knowing as we do that the degree of fluidity has an effect and should, if possible, be recorded, I have in combination with other new features of this system provided means by which such information can be definitely recorded. At *R R*, Figs. 3 and 4, is an arrangement made possible with this system by which we can measure the fluidity of molten metal by the height a metal will raise in a long thin wedge. These fluidity and life measuring strips are 8 inches long by ⅜ inch wide. The base measures ⅛ inch and runs up to $\frac{1}{8\frac{1}{4}}$ inch. They are a very sensitive barometer to denote both the fluidity and life of metal, as will be found by any that may adopt the system.

Having the fluidity strips poured in a vertical position, as arranged in this system in connection with heavier bodies, prohibits any forced unnatural pressure to be exerted while pouring. The metal cannot rise in the fluidity strips any faster than in the test bars, and hence the metal must have a gradual natural rise. Their measurement can be accepted as practical and as representing the true fluidity and life of the metal at the time it was poured. Take such fluidity strips and cast them flat, the length they run is greatly determined by the way they are poured, a quick dash at the start and you might be able to make them run two inches farther than if they were poured easily, whereas, when poured vertically, as in this system, if there is a quick dash at the start its force is spent in filling the gate *D*, and by the time the metal is raised up to a level of the fluidity strips the action of pouring is steady, causing a natural gradual rise.

I would at this point call attention to the principle involved in obtaining the contraction by means of this system. We referred to the expansion of metal at the moment of solidification at the fore part of the paper. It cannot but be seen that by the contraction tips *M M* and *A A*, Figs. 1, 2 and 3, being formed in sand and the free chill *V*, Figs. 2 and 4, by means of the gauge *O*, Figs. 3 and 4, that all freedom is allowed for expansion at the moment of solidification, hence overcoming the great objections of casting between fixed iron ends or yokes. The method for measuring the contraction is seen at Fig. 3. Here a light gauge, *I*, Fig. 4, is set over the contraction tips *M M*, and by means of a micrometer as seen at *G*, Figs. 3 and 4, the contraction or the difference between the tips on the gauge and test bars are measured by the thousandth part of an inch in a very simple manner. The same micrometer is used for measuring the section of a test bar at the point of fracture as shown at *Y*, Fig. 8. A bar should not be measured until after it is broken, so as to enable measuring right at the point of fracture as the least variation in the size of bars greatly affects the strength, and while a bar should measure the same along its center or breaking portion still there are causes which affect a slight variation at this point, and which is best noted as above stated.

For relative comparison with foreign shops, or in all cases where outsiders might require specifications of the strength, all irons that would not show grey in the rough round test bar should be cast off from the patterns *N N* placed over the round bars *H H*, which gives a test bar as seen at *T*, Fig. 3, and then turn down the swell *T* to a diameter of 1.1284″, which would equal 1 inch square in area, but for a shop's own comparison in

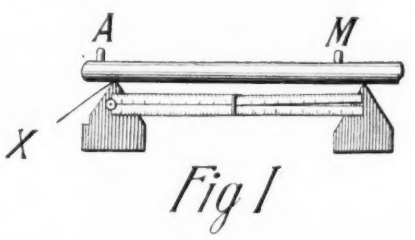


Fig I

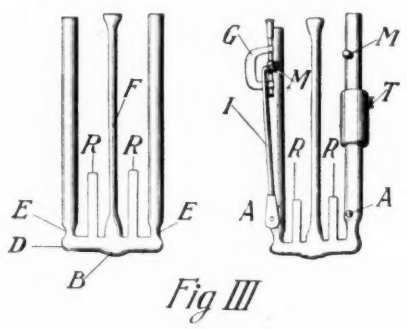


Fig III

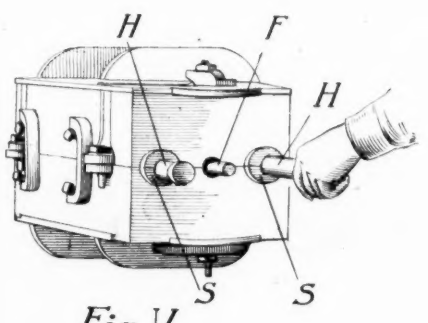


Fig. V

Fig VII

mixing metals the 1.1284″ round bar in the rough should closely meet all practical requirements. Of course, if any would adopt the turned bars for shop comparisons, as well as for outsiders, they would only be assured of the best possible comparison. Then again, in hard or soft grades a founder could cast one bar with the swell and one of the straight, as seen at Fig. 3 in the same flask, and then by turning down the swelled bar to the exact diameter of the straight bar, an intelligent comparison of the difference between the two could be obtained, as by this process of casting one is fairly sure of all bars being sound, and hence one of each kind would answer. A point I would here make is that of the system as advanced being practical for all kinds of cast-iron, the only difference being in the manipulation required in treating conditions as affecting chilling and rough or turned bars which in both cases before testing should be as near as possible to 1.1284″ diameter. I have at this writing lying at my desk 72 test bars consisting of 18 bars ½ inch square, 18 bars 1 inch square, 18 bars 1⅛ inches diameter in the rough, and 18 1⅛ inches diameter turned bars. These test bars comprise mixtures of sash weight, stove plate, light and heavy machinery, car wheels, and

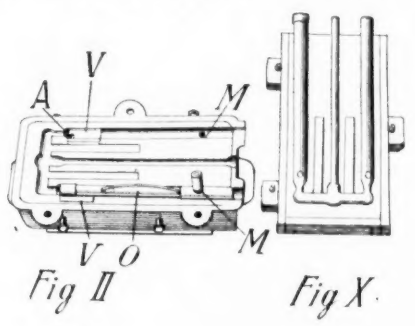


Fig II

Fig X.

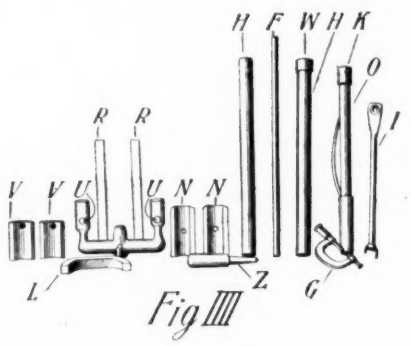


Fig III

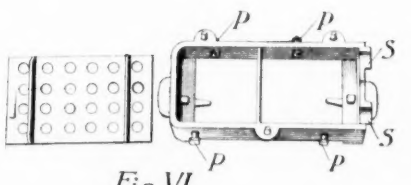


Fig VI

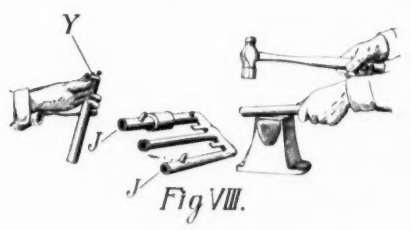


Fig VIII.

Fig IX

chill roll metal obtained from leading specialists in the above lines and all consist of the actual mixtures used for their respective work. In a few days I expect to receive a series of tests from gun metal, also a few other grades which, when all are received, I shall have analyzed and with a review on such give the same to the trade. These tests, combined with my experience, only go to further prove to me the practicability of the system here advanced as being qualified to mold and obtain a relative test of all grades of cast-iron for a shop's own mixtures or for outsiders.

Referring back to the question of chilling, it cannot but be readily seen that as arranged by this system the test bar and the chill must remain in close contact until removed by hand, hence truly recording the full chilling qualities of the iron. The old methods and which are chiefly practiced today, of casting test bars between fixed iron ends or yokes only chills in an erratic, partial manner, owing to the test bar pulling away from the chill the moment it commences to contract, and while in any case it will not record the full chilling qualities of an iron, and presents but a partial test, we also find this can even be erratic owing to the fact that the degree of fluidity at which a mold is poured affects the length of time such will remain in contact with a chill, as the duller an iron is poured the quicker it solidifies, and the sooner such occurs the earlier contraction takes place, or the test bar pulls away from the chill. All records compiled from chilling between yoke or flask ends cannot be other than misleading and untrue.

At *V V*, Figs. 2 and 4, can be seen the chill used in this system; they are simply two half circles 3 inches long by $\frac{7}{16}$ inch thick, having a hole drilled in them to fit over the pattern tips *U U*, Fig. 4, and into which the tip *K* of the contraction gauge, Fig. 4, fits when punching the upper tips *M M* with the plug *Z*, Fig. 4. These chills are set on over the pattern before starting to fill the nowel with sand, and in shaking out must, of course, be picked up and used as long as they last. They are made of a soft steel shaft and after being drilled out are then split as seen. They should be no thicker than $\frac{7}{16}$ inch, or less than that, for in chilling it must be remembered that the thickness of a chill and the body of metal to be chilled affect one the other. Should we use a ½ inch chill on these test bars instead of a $\frac{7}{16}$ inch chill we would chill them deeper, and, again, if we would hold to the $\frac{7}{16}$ inch chill, but increase the size of the body of metal in the test bar, we would have less chill than if the body of metal was smaller. The only weak point which I find in this system is in the chilling. Take very hard irons such as would go all perfectly white in an unchilled ½ inch square test bar, would in this 1⅛ inch round test bar generally chill all the way through the thickness of a test bar. I did think of making the chilling end of these test bars about 2 inches diameter and use the same $\frac{7}{16}$ inch chill in order to qualify the one arrangement to meet all kinds of iron, but as this would make the bar so clumsy and not so effective for the general run of work I thought I would not sacrifice convenience for the majority in order to suit the minority, but for this latter and which embraces such irons as are used in car wheels, chilled rolls and gun metal, the bottom or chilled end of the test bar, which is 3 inches long, could be increased to 2 inches diameter, and any iron that would go all white in this diameter of a bar should then be tested outside of this system by means of any diameter thought necessary. I do not wish any to infer from the above that the system because one chilling arrangement was not fully qualified to meet the requirements of such hard irons as chill roll and car metal that it was not good for obtaining the strength, contraction, shrinkage and fluidity of such metal. To any that may question this I would say that I now have at my side test bars cast off such round patterns as this system uses that are turned, and in the rough from car wheel and chill roll mixtures, and the series of 24 bars from this metal, which I hold, fully prove the 1.1284″, or closely 1⅛ inch round test bars are practical for such metal.

To find the depth of a chill with these round test bars hold the chilled ends (after a bar has been tested) over a solid piece of iron, and strike it as seen in Fig. 8. A notch being cast in the chilled end opposite the chilled side as seen at *X*, Fig. 1, permits the bar being readily broken when held as above described. To measure the depth of chill consider only that portion turned white, and the depth it has been chilled must be defined by the eye.

Shrinkage is a quality that never before

to the writer's knowledge has there been any means by which it could be recorded. Such information cannot but be of the utmost value to the foreman or manager in proving the necessity of good feeding heads and feeding in order to make solid castings from iron having high shrinkage, which in soft or gray irons is not to be expected to the degree found in strong iron and which, in fact, with very soft iron in many castings cannot be observed and may often swell up instead of showing a shrink hole when solidified.

Many founders can trace back to heavy losses caused by shrink holes due to improper feeding that had they been forewarned of excessive shrinkage, they could have often guarded against. By the system here presented such information is made obtainable in a very simple manner. By noticing the top of the flask at *S S*, Figs. 5 and 6, it will be seen that the upper end of the test bars are cast open, one inch of which is formed by the iron end of the flask being drilled out to an easy fit for the patterns. When pouring the mold, the metal as soon as it settles to a level is chilled on its circumference by the iron ends of the flask, so as to form a chilled crust or shell which will record the highest level of the metal before it commences to settle down to supply any shrinkage which the fluid metal below may exact. As the liquid iron settles down to supply any shrinkage, it will leave a conical hole in the top of the test bars and pouring runner, which will look something like *J J*, Fig. 8. To measure the amount of this shrinkage, use an apothecary graduating glass which will hold 180 minims of water. (A minim of water is equal to one drop and in weight is equal to one grain.) The castings are held in an upright position and the concave holes carefully filled, as illustrated by Fig. 9. By noting how many grains of water was in the graduate before starting to fill the shrink holes in the test bars, and deducting the same from that remaining in the graduate after the shrink holes are filled, you have a record, which can be filed, of the shrinkage in grains.

All experienced heavy work founders know that the hotter metal is poured the greater the shrinkage, and in this respect it wholly differs from contraction, which from experiments I have conducted on this point, show that the degree of fluidity at which a metal is poured in no wise affects the contraction. Of course, the hotter a metal the more it can strain a mold, but a strain and a natural contraction are two different things.

Any one that will experiment in this line with molten metal suitable for running a mold will find that shrinkage and contraction are not equally controlled by the fluidity of a metal, and that the former is the element affected, whereas the latter shows no change. We must in making a record of the shrinkage also take note of the fluidity strips, and the further we find the two diverging the greater the shrinkage. This being the first time that it has been shown practical to record fluidity and shrinkage, I regret space will not permit me to more closely detail rules, etc., admitting of logical deductions. These elements, with many others, I shall illustrate in a coming work entitled, "Studies in the Science of Mixing and Testing Cast-iron." There is much need of physical tests to go hand and hand with chemical analysis in aiding intelligent mixing and melting of cast-iron. The practice of the latter to day requires a radical evolution before we can expect to ever truly make intelligent relative physical comparisons with mixtures in cast-iron, let it be in our own shops or in foreign ones.

For years back I have realized the weak points and non practicability of present methods, and I respectfully submit this article as a culmination of my experience, knowledge and study of the subject, and what original methods I consider as necessary in the question of molding and casting rough or turned test bars to insure a correct treatment in obtaining a knowledge of true physical qualities of cast-iron. Being the first to advocate the round bar as the best form, it is but natural to expect that I would labor enthusiastically to prove the correctness of the stand I had taken against the use of the square test bars cast flat and the incorrect methods as used at the present day for testing the physical qualities of cast iron.

There is a great deal more that might be said in this paper on the subject of testing and the properties of iron, but as I have already taken too much space, I shall defer it for other articles. Suffice to now say, it is well known that with present methods in use for testing cast-iron we obtain very erratic results, and are often wholly unable to account for them. The test bars may be poured out of the same ladle, at the same time, look sound, and measure alike, still for all this not test the same. There certainly is a cause for such erratic effects, and I lay this chiefly to the use of the square cornered test bar cast flat, and would say that any adopting the system herein outlined cannot but find a radical improvement in obtaining true knowledge of physical phenomena, and be much more assured of accuracy in recording relative comparison in mixing and testing cast-iron than is possible with present methods.

Mr. Ambrose Swasey, of the firm of Warner & Swasey, sails for Egypt next month, for an extended tour. He will be accompanied by Mrs. Swasey.

John J. Grant and wife sail for Paris on the 15th of September. Mr. Grant goes for the purpose of superintending the erection of the ball plant sold to A. Clement, the largest bicycle manufacturer of France Mr. Rolin White, son of T. H. White, President of the Cleveland Machine Screw Co., will accompany Mr. Grant, and have charge of the erection of the plant. They will make quite an extended tour through England, France, Germany and Switzerland the company having had many enquiries from abroad for their automatic screw machines.

MANUFACTURES.

The Gaffney (S. C.) Cotton-mills will erect additional bu ldings and put in new machinery.

The Cannon Mfg. Co. (cotton), of Concord, N. C., has declared a semi annual dividend of 4 per cent.

Colonel Trippett will rebuild his cotton-gin at Bedford, Tex, and put in new equipment of machinery.

The Pee Dee Mills at Rockingham, N. C., will put in 60 new looms and other machinery for heavy goods.

The Orion Knitting mills, at Kinston, N. C., which have been shut down for some time, have resumed operations.

W. A. Polk and associates have determined to erect a cotton compress, Corsicana, Tex., and are now perfecting details.

The Hawley Silk-mills, at Port Jervis, N. Y., employing 300 operators, and valued at $50,000, were destroyed by fire recently.

The stockholders of the Massachusetts Cotton-mill, of Lowell, Mass., have voted to increase the capital stock and build another mill.

James J. and John A. Rohan have incorporated the John Rohan & Son Boiler Works Company, St. Louis, Mo., with a capital stock of $10,000.

The Almy Water-tube Boiler Co., Providence, R. I., issue a catalogue of the Almy boiler which contains quite complete illustrations and description.

HYDRAULIC DAMPER REGULATOR.

This is a new damper regulator which works by water pressure. Price, nickel plated, with chain and bracket, $125. Write for discounts. Guaranteed as sensitive and reliable as any.

MASON REGULATOR CO., Boston.

BUFFALO BLOWERS. UNEQUALLED EFFICIENCY, DURABILITY, MINIMUM POWER. BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

BUFFALO BLACKSMITH TOOLS. PUNCHES, SHEARS, DRILLS, HAND BLOWERS, FORGES, ETC. BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

GRANT GEARS

Gear Wheels, Gear Cutting, Cat. free. Book $1.00. George B. Grant, Lexington, Mass., Philadelphia, Pa., Cleveland, Ohio.

MECHANICAL DRAWING.

By Prof. CHAS. WM. MacCORD.

Part I.—Progressive Exercises.
Part II.—Hints to Draftsmen.

4to, cloth $4.00

JOHN WILEY & SONS, NEW YORK.

JESSOP'S STEEL

FOR TOOLS, DRILLS, DIES, &c.

ALL KINDS IN STOCK. Manufactory, SHEFFIELD, ENG. Chief Am. Office, 91 JOHN ST., N. Y. WM. JESSOP & SONS, LTD. Established a century ago. Medal World's Columbian Exposition 1893.

"Star" Foot Lathe Swings 9x25 in. LATHE Screw Cutting Automatic Cross Feed, etc. LATHE Scroll Saws, Circular Saws, Lathes Mortisers. LATHE Catalogue Free of all our Machinery.

Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N.Y.

BORING AND TURNING MILLS

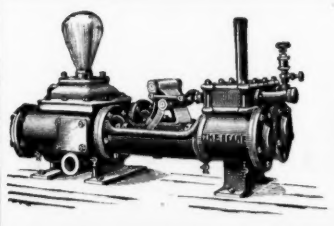
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.

We have a variety of sizes and a large stock for immediate shipment.

BRIDGEPORT MACHINE TOOL WORKS,

E. P. BULLARD, Prop. BRIDGEPORT, CONN.

New York Office, 86 LIBERTY STREET.



THE DEANE OF HOLYOKE STEAM PUMPS

DEANE STEAM PUMP CO., HOLYOKE, MASS.

CRESCENT STEEL

ESTABLISHED 1865 ✻ INCORPORATED 1889.

CRESCENT STEEL CO.

480 PEARL ST. NEW YORK PITTSBURGH, PA. 64 & 66 S. CLINTON ST. CHICAGO.

"LIGHTNING" SCREW PLATES IN Birmingham ("Stubs") Wire Gauge Sizes, SCREW GAUGE SIZES AND SIZES IN FRACTIONAL PARTS OF AN INCH. For BICYCLE REPAIRERS, ELECTRICIANS and others. Adjustable Dies with Case-hardened Guides. Send for Supplement No. 1.

WILEY & RUSSELL MFG. CO., GREENFIELD, MASS., U. S. A.

"R. MUSHET'S SPECIAL STEEL"

SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.

Sole Representatives in the United States.

B. M. JONES & CO.,

BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

LATHES! PLANERS!! SHAPERS, &c.!!!

We Were Not Awarded a Medal at the World's Fair,

because our tools were not on exhibition there but our customers write us that every tool built by us has proven exactly as represented. Our claim is that "Our tools are of the latest and most approved designs, while the workmanship, material and finish are of the highest order." Our catalogue will tell you all about them. Prices quoted on application. No time like the present to buy!

SEBASTIAN LATHE CO.,

117-119 Culvert St., CINCINNATI, O.

ASBESTOS CEMENT FELTING,

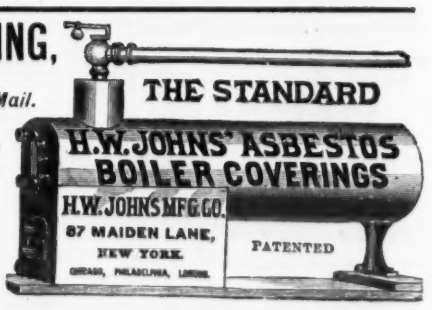
FOR LAGGING LOCOMOTIVE BOILERS.

Samples and Descriptive Price List Free by Mail.

We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.

H. W. JOHNS MANUFACTURING CO.,

87 Maiden Lane, NEW YORK.



The Cowpens (S. C.) Cotton mills will put in 56 additional looms, making a total of 200. These mills will then manufacture sheeting Nos. 19 and 22, yarns 68 and 68 pick.

The Tingue Manufacturing Co., Ansonia, Conn., makers of silk plush, has started on full time, with 300 hands. The mill has been almost entirely closed since July, 1893.

The Brown & Sharpe Mfg. Co. and Darling, Brown & Sharpe Providence, R. I., have resumed work in all their departments after their usual annual vacations.

A building permit has been taken out for a two-story frame and iron machine shop, 100x66 feet, as an addition to the Hoopes & Townsend Bolt Works, Hamilton and Broad streets, Philadelphia.

Smith & Winchester Company, Boston, Mass., has issued an attractive catalogue of the Winchester boiler for steam and hot water heating. It is quite fully illustrated; also different radiators for heating.

The Deane Steam Pump Co., of Holyoke, Mass., have contracted with the town of Boothbay, Me., to put in pump and boilers for waterworks at Boothbay Harbor, and also for fire pump for the Cascade mills at Oakland, Me.

The Berlin Iron Bridge Co., of East Berlin, Conn., have received the contract for the new plant of the Fairfield Copper Co., at Monroe, Conn. The plant will be entirely of iron and steel, no woodwork being used about the construction.

The Pennsylvania Steel Company are now preparing the iron work for the new tinning plant which the Lalance & Grosjean Manufacturing Company will erect in connection with their rolling-mill, at Harrisburg, Pa. The new structure will be 60x120 feet in size.

Jones & Laughlins, Pittsburgh, Pa., are constructing a new roll shop in connection with their mills, and for serving same will put in a Morgan Engineering Co.'s standard construction traveling crane, with a lifting capacity of 15 tons, span, 40 feet, all motions operated by electricity.

Jones & Lamson Machine Co., Springfield, Vt., has issued the fourth edition of *Rapid Lathe Work* fully illustrated, which, as we have before said, is one of the most interesting catalogues published. They have also issued a German supplement to this catalogue, in which those who read German will be interested.

The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, write us, under date of August 20th: "You will be interested, perhaps, to learn that we have received more orders in the last three weeks than in any equal time since we have been in business, and the prospects for continuance of this good business are bright."

The Lodge & Davis Machine Tool Co., of Cincinnati, O., have just received an order from the White River Lumber Co., of Butler, Wis., for a complete equipment of machine tools, including lathes, planers, bolt cutters, upright and radial drills, milling machines, etc. It will be one of the most complete repair shops in that section of the country.

The foundations for the new shops of the Buffalo & Susquehanna Railroad at Galeton, Pa., are nearly completed, and it is expected that work will be commenced this week on the iron and brick work. The shops will include a paint shop, a roundhouse containing 17 stalls, machine shops, car shops, planing-mill and an office. There will also be a 60 foot turn-table.

The new power station for the Hartford Street Railway Co., at Hartford, Conn., will be designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn. It will be 66 feet wide and 233 feet long, with a steel frame covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron covering. When completed, it will be one of the most complete stations of the kind in the country, and will be absolutely fireproof.

The plans for five bridges are now being completed by the Bureau of Surveys of Philadelphia, and bids will be advertised for in about a month. Advertisements for those at Sixty-third street, over the Baltimore Railroad, and Wayne avenue, over the Chestnut Hill Railroad, have already been published. The other three bridges will be built at Seventeenth street, under the Connecting Railroad; Sixth street, over the Reading, and Thirty-third street, over the Reading & Pennsylvania.

John J. Grant, of the Cleveland (O.) Machine Screw Co., writes us: You may be interested in knowing that we are to enlarge our plant. We shall break ground at once for a new shop, 200 feet by 40 feet, four stories high; also a fine office building two stories, upper story for drafting room. The shop will be of brick with stone trimmings and of slow burning construction, floors 7 inches thick. The office and drafting room will be fitted with fire-proof vaults and all the modern arrangements for such a building. Our business is very good and the orders already on hand and the business outlook makes the addition necessary. We are designing a testing machine for testing balls. This machine will test balls under all conditions, rotating under various pressures and varying diameters, both as to size of ball, and in thrust bearings, diameter of path. The machine will also be arranged to test for frictional resistance, all forms of bearings and any material. While the cost to us will be many thousands of dollars the advantage to us will more than compensate for the outlay. The many letters we have from engineers on the subject of ball bearings, and the scant data available on the subject induced us to design the machine.

The Skinner Chuck Co., New Britain, Conn., has brought out a new chucking jaw for use on the face plates of large machine tools which are not ordinarily fitted with chucks. The jaw consists of a heavy cast-iron base, which has a tongue upon it to fit the slot of the plate upon which it is to be used. The outer end is secured to the plate by an ordinary bolt and nut, while the inner end is secured by a clamping device. This device consists of an adjustable bolt, which, when in place and adjusted to suit the thickness of the plate, is tightened by turning a screw which passes through the block sidewise, and is tapered to fit a taper hole in the other bolt, which is thus drawn up tight. By this means a secure fastening is obtained for the inner end without a projection to interfere with the work, and the tightening bolt is always readily accessible at any time. To reverse the jaw it is necessary only to remove two screws, reverse the upper portion of the jaw, and replace the screws, steel washers let into counterbored seats in each piece accurately positioning the parts and taking the strain. The jaws, screws and bolts are made of steel, case hardened, and pains are taken to make the work as good as that done upon the best chucks. They are designed to be used in sets of three or four.

Machinists' Supplies and Iron.

New York, August 25, 1894.

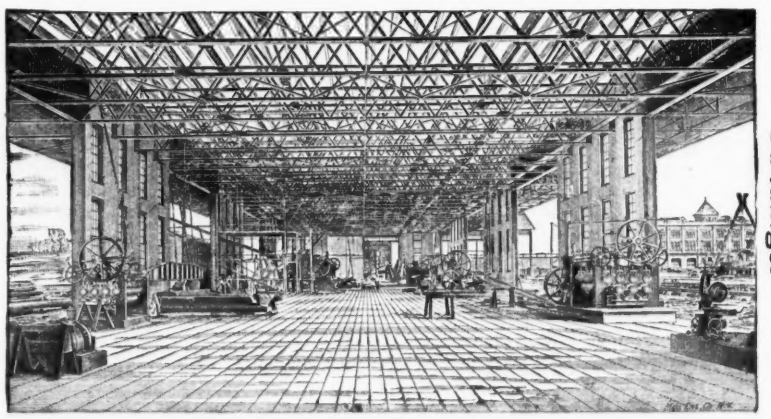
Iron—American Pig—We quote standard brands, $12.50 to $13 for No. 1; $11 to $12 for No. 2. Southern brands, $11.50 to $12.25 for No. 1; $10.50

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON.

NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

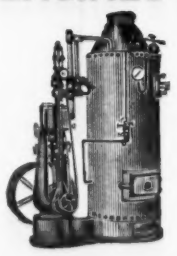
Engineers, Architects and Builders of Iron and Steel Bridges and Buildings.



The above illustration is taken direct from a photograph, and shows the interior of the first floor of a Ship Shed designed and built by us for the Newport News Ship Building and Dry Dock Co., at Newport News, Va. The building is 60 feet in width by 320 feet in length—with an overhang 12 feet wide on the outside entirely around the building. The door openings are every 40 feet and are made 40 feet wide, so that teams can drive in and out for taking in the raw material and bringing out the finished product.

SEND FOR OUR ILLUSTRATED CATALOGUE.

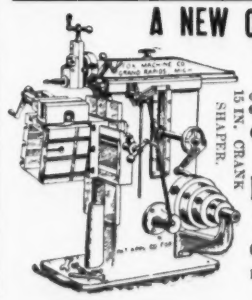
COOKE & CO.,
163 & 165 WASHINGTON ST.,
NEW YORK.
ENGINES and BOILERS.



VERTICAL,
HORIZONTAL,
STATIONARY,
PORTABLE,
Plain and Automatic.
Write for Catalogue and mention this paper.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

A NEW CRANK SHAPER.



NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co.,
325 Nor. Front St.,
Grand Rapids, Mich.
135 Finsbury Pavement, London, England.

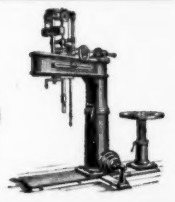
REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.

To be driven from a Stud in the Face Plate.

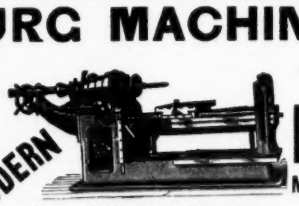
No.	INCH.	PRICE.	No.	INCH	PRICE.
1	¾	$0.60	10	2¼	$1.35
2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set.		31.10

These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.
C. W. LeCOUNT, South Norwalk, Conn.

BETTS MACHINE COMPANY,
MACHINE TOOL BUILDERS,
WILMINGTON, DEL.



FITCHBURG MACHINE WORKS,
MANUFACTURERS OF
FITCHBURG MODERN ENGINE LATHE
AND OTHER METAL-WORKING MACHINES,



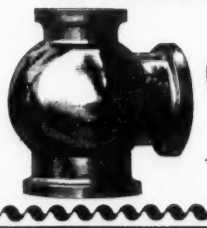
Horizontal Boring and Drilling Machine.

THE CELEBRATED
SEND FOR CATALOGUE E.
FITCHBURG, MASS.

BOSTON GEAR WORKS
35 HARTFORD ST., BOSTON, MASS.
GEARS, ALL KINDS, SMALL OR LARGE.
300 LIST IRON, 600 LIST BRASS
Catalogue FREE to any Business Firm.

MILLING CUTTERS
MILLING CUTTERS WITH STRAIGHT OR SPIRAL TEETH. SIDE MILLING CUTTERS
ANGULAR CUTTERS. END MILLS. MILLING ARBORS
J. ERLANDSEN.
172 CENTRE ST. NEW YORK

BUILDERS IRON FOUNDRY,
PROVIDENCE, R. I.
(Patented.)



GLOBE SPECIAL CASTINGS FOR WATER-WORKS, MILLS AND RAILROADS.
The form is the strongest possible to resist bursting strains.
All common sizes in stock. Catalogue mailed on application.
M. J. DRUMMOND, Sales Agent, 192 Broadway, New York City.

P. H. & F. M. ROOTS,
Connersville, Indiana.
Chicago Office, 1405-10 Manhattan Building.
MANUFACTURERS OF
PORTABLE FORGES, TUYERE IRONS, ETC.

ROOTS' NEW ACME HAND BLOWERS
Slow speeded, Force-blast, Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, etc.
S. S. TOWNSEND, Gen. Agt. COOKE & CO., Selling Agts. } 163 & 165 WASHINGTON ST., NEW YORK.
In Writing, Please Mention This Paper.

WORTHINGTON
PUMPING ENGINE
FOR
WATER WORKS.
SIMPLE, COMPOUND, OR TRIPLE EXPANSION, HORIZONTAL OR VERTICAL
HIGHEST DUTY GUARANTEED.
COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St.
BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

to $11 for No. 2; $10 to $10 25 for No. 3; $10.50 to $11 for No. 1 soft; and $10.25 to $10.75 for No. 2 soft. Foundry No. 4, $9.75 to $10 25.

Antimony—We quote L. X., 8¾c. to 8¾c.; Cookson's, 9¾c. to 10c.; Hallett's, 8⅝c. to 8¼c.; and U. S. French Star, 10c.

Lard Oil—We quote 55c. to 57c., according to quantity.

Copper—The market is scarcely active, with prices favorable to the buyer. For Lake Copper 9¼c. to 9¼c is asked, but large quantities are still bought at 9c. or even lower. Holders of Casting Copper are more liberal in their offers; it is said that 8½c. has been accepted.

Lead—The market is very unsettled. Spot lead is quoted at 3.40c. to 3.45c., futures at 3.30c. to 3.35c. The demand is very light.

Spelter—The market is weak; 3.45c. is quoted for New York delivery. Buyers are well supplied, and are not eager to buy.

Tin—The market closed steady, with slightly higher prices. For spot 19.30c. is asked, and sales made at this figure.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 80 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Draftsman—Young man, tech. educ'n and exp. in ice machine design, wants pos. Box 142, Am. Mach.

Good mach. & dftsman des pos as dftsman; good des'r; steam eng. & gen. mach'y. Box 1, Am. Mach.

Draftsman & mech. eng. desires engagement; 14 years exp. in shop and office. Box 149, Am. Mach

Mech'l eng., member of A. S. M. E., is open for a pos. as chief draftsman. Box 147, Am. Machinist.

Wanted machine shop to manufacture pat. mach. on royalty. Vollhammer, 1024 Park Ave., N. Y.

Situation wanted by a mech. engineer and draftsman with 12 yrs. exp. in general jobbing work and Corliss engine. Box 148, American Machinist.

Competent party with extensive experience and recognized abilities want pos. as supt. or designer. Vollhammer, 1024 Park Ave., N. Y.

Wanted—Active men, mech., civil, elec. engrs. or draftsmen, with spare time, well acquainted in their localities. Edwin Guthrie, Washington, D. C.

Mechanical draftsman, technical education, and experience in both drafting room and shop, wants position. Address Box 134, American Machinist

Wanted—Patternmaker; age 25 to 30; fair experience, as partner in foundry. Write J. McCash, 619 Harris Avenue, St Louis, Mo.

Situation wanted by a supt. experienced in mfg. tools and milling machines, design ways and means to economize. Box 144, Am. Machinist.

Situation wanted—A practical man with exp. & ref., wants control of foundry plant; understands his business thoroughly as mechanic and manager. Box 145, American Machinist.

Wanted—Assistant dftsman—A recent graduate from a tech. school can find steady employment at fair wages; applicant must be bright, steady and strictly temperate. Address Climax, Am Machinist.

Wanted—A first-class all-around machinist familiar with gear cutting. Address, giving age, experience, references and terms. Central New York, American Machinist.

First-class machinist who has had practical experience in designing and making tools for a milled machine screw factory; rising young man preferred; must be temperate, reliable and well recommended; state salary, experience, age. John Morrow Machine Screw Co., Ingersoll, Ont.

Experienced middle-aged American is open for position as sales office manager or agent for first-class steam or hydraulic machinery; New York or Boston; salary or commission. Mechanical Engineer, American Machinist.

Position wanted by man of 35 who has had extensive and successful experience in shop management and at the head of drawing room; is a thorough mechanic; in touch with the latest developments in mech. methods, and has fact to manage men, to avoid friction and produce best results; exp. on engines, machine tools and general machinery. Address Mem. A. S. M. E., care Am. Machinist.

Wanted—A company manufacturing special machinery of fine quality and intending to employ from one to two hundred men, desires to secure the services of a superintendent of thorough experience in the best American shops. One capable of getting out the best work at fair cost in the most expeditious way, and a thorough organizer and manager of men is the one sought for. The rigot man will be fairly paid. Address Manufacturer, 801 Market space, Washington, D. C.

Wanted—To buy good second-hand tools. Box 83, American Machinist.

Fine pattern work; estimates; specialties wanted to man'f. H. Cooper, 118 William St., N. Y. C.

Wanted—A one horse power Shipman automatic boiler and engine; wrought iron boiler, engine with reversing link. Address F. B. Husk, Brewster, N.Y.

For Sale—Foundry and machine shop in Florida. Paying business; small capital. Address Mch., American Machinist.

Ice machine builder, wishes to go in partnership with a party possessing a machine shop; has machines running & patent. Box 143, Am. Machinist.

Anyone having small foundry to lease (one in connection with machine shop preferred), address Box 150, American Machinist.

"999" is all right, but wouldn't you like a set of castings to build a working model of her sister "897" same as "999," but smaller drivers; send for catalogue. G. H. Olney, 163 Herkimer St., Brooklyn, N. Y.

For sale—A first-class foundry thoroughly equipped with modern appliances, together with the real estate on which it stands. The plant has been successfully conducted for over twenty years and is now offered for sale because of owner's death. For further particulars inquire of Thomas J. Kelley, administrator, Willimantic, Conn.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

CLEVELAND TWIST DRILL CO'S. GRIP SOCKETS. No More Twisted Tangs.

Larger drills can be used with smaller shanks than ever before. No charge for the groove in the shanks.

Send for Descriptive Price List.

Cor. Lake and Kirtland Sts., Cleveland, Ohio.

DETROIT TWIST DRILL CO., DETROIT, MICH., U. S. A.

SOLE MANUFACTURERS OF

GRAHAM'S GROOVED SHANK TWIST DRILLS AND CHUCKS.

Endorsed by Practical Mechanics Everywhere. Send for Catalogue.

WILL BE SOLD LOW.
MACHINE TOOLS, BOILER TOOLS,
HAMMERS.

IRON PLANERS.
19 in. x 3 ft. Wheeler.
20 " x 6 " Pratt & Whitney.
22 " x 5 " Pease
24 " x 4 " Wood & Light.
24 " x 5 " New Haven.
24 " x 6 " Wood & Light.
26 " x 7 " N. Y. S. Eng. Co.
30 " x 10 " Bancroft.
35 " x 7 " Hewes & Phillips.
36 " x 8 " Lathe & Morse.
60 " x 24 " Steam Eng. Co.

SHAPERS.
8 in. Stroke Gould.
16 " " Gould & Eber.
22 " " Triple Geared.

DRILLS.
3 Spindle Slate Sensitive.
20 in. Swing Wheel Feed.
25 " " Prentice, complete.
26 " " Prentice Friction.
40 " " Cinti, complete.
48 " " Old Style.
Radial Drill, 86 in., complete.

MILLING MACHINES.
Brown & Sharpe No. 6 Plain.
Brainerd Plain Table 30 x 8.
Brown & Sharpe No. 1 Universal.
Lincoln Pattern, very cheap.

BORING MILLS.
Bement No. 2 Hor., B. & D.
Bement Cyl. Borer, 12 to 36 in.
Upright B. & T. Mill, 38 in.
Pond Upright B. and T. Mill, 6 ft.
B. & S. Upright Turret Borer.

ENGINE LATHES.
13 in. x 6 ft. Blaisdell.
13 " x 4 " P & W. Taper.
14 " x 7 " Bogert, improved.
15 " x 5 " Pond.
16 " x 6 " New Haven.
16 " x 6 " Ames.
18 " x 8 " Putnam.
20 " x 10 " Fitchburg
22 " x 8 " Harrington.
22 " x 10 " Pond.
24 " x 12 " Putnam.
34 " x 8 " Putnam
35 " x 15 " Hewes & Phillips.
36 " x 24 " Old Style 'cheap.'
36 " x 17 " Ferris & Miles.
48 " x 17 " Hewes & Phillips.

HAMMERS.
50 lb. Helve, Bradley Up'g't.
800 " Steam, Ferris & Miles.
1200 " Drop with Lifter, Farrel F'd'y's Make.

BOILER TOOLS.
Rolls, 6, 8 and 10½ ft.
Hor. Flange Punch, "H. and J."
Flange Clamps, 6 ft.
Bement Plate Planer, 16 ft.

MISCELLANEOUS.
Imp. Brass Cabinet Turret.
P. & W. 22 in Turret Lathe.
Acme, 3½ in. Bolt Cutter.
Slotters 10 and 18 in. Stroke.
Putnam Tool Grinder.
Screw Machine, 2 in. hole.
Hand Jib Crane, "Cheap."
Allen Port Bridge Riveter.

J. J. McCABE,
SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.
14 Dey St.,
NEW YORK.

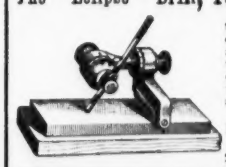
MACHINERY BARGAINS.

10 in. Post Drill.
10 " " Auto. Feed to Table for Butt Drilling.
1, 2 and 3 Spindle Sensitive with and without Power Feed.
2, 3 and 4 Spindle Gang Drills.
20 24, 26, 28, 30 and 44 in. "
30 in. Swing Post Drill.
5 ft. Arm Radial Drill.
12 in. Stroke, 16 in. x 16 in. Crank Planer.
16 in. x 4 ft. Planer.
24 " 4, 5 and 6 ft. Planer.
28 " 5 and 8 " "
30 " 5, 8 and 10 " "
60 " 20 " "
72 " 25 " "
9, 12, 16 24 and 26 in. Stroke Shaper.
10 in. Stroke Slotter.
Hyd. Rivetting Machine.
Crane, Both Al.
Punch and Shear.
Plate Planer.
11 in. x 5 ft. Eng. Lathe.
14 " 6 " " "
15 " 6 and 8 ft. Eng. Lathe.
16 " 5, 6, 7 and 10 ft. Eng. "
18 " 6, 7 and 8 " " "
20 " 5, 6, 7, 8 and 10 ft. " "
21 " 10 and 13½ ft. " "
24 " 19 " " "
25 " 16 and 24 " " "
26 " 10½ " " "
32 " 16 " " "
35 " 13 " " "
52 " 35 " " "
57 in. Double Head Driving Wheel Lathe.
Bement Car Axle Lathe.
1¼ & 2 in. Bolt Cutter Schenk's.
7 Spd'l Nut Tapper, Dunel.
2 Spd'l Profiler, No. 1 P. & W.
No. 1, 2 and 2½ Screw Machs. P. & W.
No. 1 Lincoln Pattern Miller.
Hand Millers, Screw Slotters, Mill and Cutter Grinders.

Lot of Miscellaneous Machinery, Engines, etc. Send for Latest List.

GEO. PLACE MACHINE CO.,
Offices: 145 BROADWAY and 86 LIBERTY ST.
Warehouse: 511 and 513 WEST 13th STREET,
NEW YORK.

The "Eclipse" Drill, Tool and Graver Sharpener.

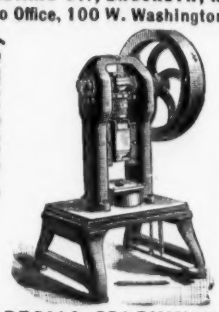


The only practical device for the re-sharpening of drills or any other tools requiring a flat surface and fine edge. It can be adjusted to any angle, and by aid of the degree or index marks the drill or tool can be set to the desired angle almost instantly.

Price, Size A $1 75, sent post paid on receipt of price.

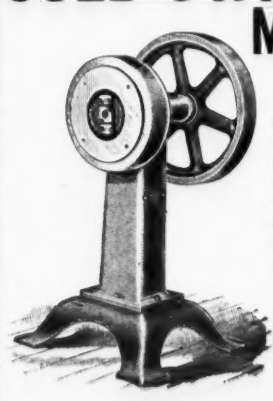
EZRA F. BOWMAN & CO.,
22 E. Chestnut St., Lancaster, Pa.

E. W. BLISS CO.
1 ADAMS ST., BROOKLYN, N. Y.
Chicago Office, 100 W. Washington Street.



PRESSES, PUNCHES, SHEARS, DIES, DROP HAMMERS,
SPECIAL MACHINERY.
The STILES & PARKER PRESS CO.

COLD SWAGING MACHINE



The Dayton Swaging Machine is the best for reducing and pointing wire and tubing. If interested address the manufacturers,

EXCELSIOR NEEDLE CO.
Torrington, Conn.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.
13 in. x 5 ft. Phenix.
14 " x 6 " Bogart.
15 " x 6 " Blaisdel.
15 " x 8 " Fitchburg.
16 " x 6 " Perkins.
16 " x 7 " Bement.
16 " x 6 " F. E. Reed.
18 " x 6 " New Haven
18 " x 8 " Pease.
18 " x 8 " Blaisdel.
18 " x 10 " "
20 " x 6 " Bullard.
29 " x 12 " Fifield.
30 " x 12 " Blaisdel.
37 " x 14 " Old Style.

PLANERS.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 " x 24 " x 6 " Whitcomb.
24 in. x 24 in. x 10 ft. Pease Planer Co.
28 in. x 28 in. x 7 ft. New Haven.

SHAPERS.
10 in. Juengst Crank.
10 " Wood and Light Traverse Head.
15 in. Juengst Crank.
18 " Putnam Traverse Head.

HAND LATHES.
4 10 in. x 41 in. Garvin.
1 12 " x 4 ft Garvin.
1 14 " x 4 " Standard.
1 12 " x 5 " Back Geared.
2 20 " x 6 " Back Geared.

MIS ELLANEOUS.
Garvin Profiler, one Spindle.
6 in. Bement Slotter.
42 " Gould & E. Auto. Gear Cutter.
16 in. x 5 ft. Gage Square Arbor Fox Lathes.
5 in Cutting off Machine.
No. 2 Springfield Tool Grinder.
" 4 " " "
30 in. Squaring Shear.
No. 2 Pratt & Whitney Die Sinker
No. 3 Garvin Cutter and Tool Grinder.
No. 2 Garvin Cutter and Drill Grinder.
No. 1 Slate Marking Machine.
No. 2 Garvin Automatic Tapper.
Garvin Die Slotter.
Garvin Wire Spring Coiler.

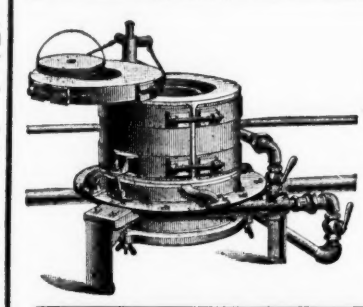
Also, a large number of other machines. Write for complete list and detailed description.

THE GARVIN MACHINE CO.,
LAIGHT & CANAL STS., NEW YORK.
Also 51 North 7th St., Philadelphia, Pa.

PRATT INSTITUTE,
BROOKLYN, N. Y.
Department of Science and Technology.

The two years' Day Course in machine work gives a thorough preparation for practical work Tuition $30 00 per term of six months. Evening Class meets on Monday, Wednesday and Friday of each week for course of six months, beginning September 24. This course affords the best possible opportunity for beginners at the trade to obtain a thorough training in the use of all the shop tools Tuition for term of six months, $15.00, Tools and materials furnished without extra charge. For tuition and further particulars, address,

F. B. PRATT, Secretary.



AMERICAN GAS FURNACE CO.,
OIL GAS PLANTS
Gas Blast Furnaces & High Pressure Blowers
For the economical generation and systematic application of HEAT.
CATALOGUES ON APPLICATION.
No. 80 Nassau Street, - - NEW YORK.
English Agency:
Chas. Churchill & Co., Ltd., 21 Cross Street, Finsbury, London, E. C., England.

NEW AND SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.
3 24 in. x 12 ft. New Style Heavy Engine Lathes, new.
1 each 22 in. and 24 in. x 12 ft. Standard, new.
1 each 21 x 8 and 11 Lodge & Davis, 2nd hand.
1 19 in. x 6 Pratt & Whitney, 2nd hand.

TURRET LATHES, NEW.
3 15 in. x 5 Lever and Screw Movement to Turret.
3 12 x 4 Lever and Screw Movement to Turret.
3 22 in. x 8 Turret Chucking.

SHAPERS.
3 15 in. Crank.
2 20 in. Geared.
2 26 in. Geared.

MILLING MACHINES.
1 each No. 2 and No. 4 Garvin, 2nd hand.
1 P. & W. No. 3. Heavy Lincoln Pattern, 2nd hand.

RADIAL DRILLS.
1 52 in. Combination Upright and Radial.
1 80 in. Combination Upright and Radial.
1 120 in. Radial.

UPRIGHT & SENSITIVE DRILLS.
1 20 in. Wheel and Lever.
1 24 in. B. G. P. F.
1 3 Spindle Sensitive.
1 1 Spindle Sensitive.

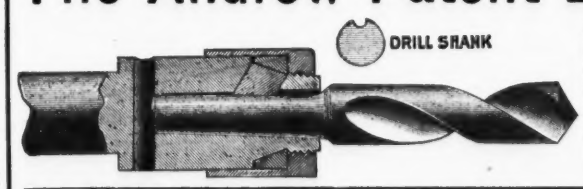
THE LODGE & SHIPLEY M. T. CO.,
CINCINNATI, O.

ELECTRICAL
Machinery and Apparatus Designed.
Automatic Devices a Specialty.
Electrical Inventions Developed.
FRED BRAINARD COREY, M. E.,
Consulting Electrical Engineer and Expert
73 Hathaway Building, Boston, Mass.

DRAFTSMEN'S comb. triangles, erasing stencils, etc. (Samples 35c. each.) D. J. KELSEY, New Haven, Conn.

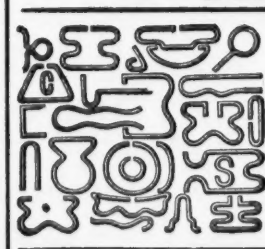
Salesman Wanted.
"COLUMBIA" CALIPERS
TAKE THE LEAD.
NO MACHINIST'S OUTFIT
COMPLETE WITHOUT THEM.
For Catalog and SPECIAL Prices address,
E. C. SMITH, - Columbia, Pa.

The Andrew Patent Drill Chuck.



The original (not copied) device to prevent twisting off Tangs. No extra cost for ANDREW'S reverse incline groove in the shanks. Chucks made direct on new or old spindles. Holds heavy taper-shank tools from dropping out. Best Practical Chuck in the World. Endorsed by all prominent Twist Drill Makers and Mechanical Experts. Send for catalogue.

M. L. ANDREW & CO.,
CINCINNATI. OHIO.



BLAKE & JOHNSON,
WATERBURY, CONN.
Builders of WIRE FORMING MACHINES
With F. B. Manville's Patent Sliding Former,

For making articles from the coil, of either round, half-round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.

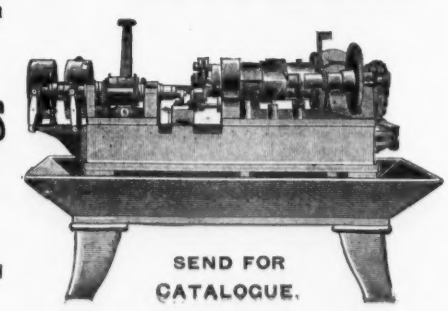
Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.

Bicycle and Labor Saving Machinery a Specialty.

STEEL BALLS

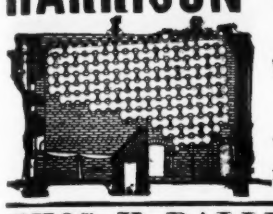
For all Anti-Friction Purposes.

WE ALSO MANUFACTURE
AUTOMATIC SCREW MACHINES
AND
SCREW MACHINE PRODUCT
OF EVERY DESCRIPTION.
Cleveland Machine Screw Co.,
CLEVELAND OHIO.



SEND FOR CATALOGUE.

HARRISON SAFETY BOILER WORKS.

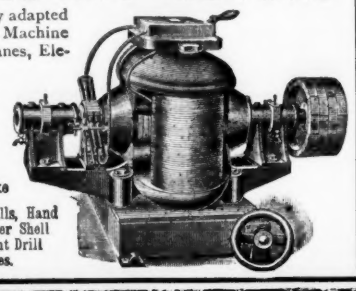


ENGINEERS AND CONTRACTORS FOR
Complete Steam Generating Plants, including
WHARTON-HARRISON SAFETY BOILERS, COCHRANE FEED-WATER HEATERS, HEATERS AND PURIFIERS, SPECIAL HEATERS, COCHRANE SEPARATORS, CAST IRON TANKS, &C.
Specifications and estimates furnished on receipt of details of requirements.
Works and Main Office: GERMANTOWN JUNC., PHILA., PA.
New York, N. Y.: 616 Havemeyer Building. Atlanta, Ga.: Chas. H. Willcox, Dallas, Tex.: Hunter & Booso.

THOS. H. DALLETT & CO.,

YORK ST. & SEDGLEY AVE., PHILADELPHIA.
MANUFACTURERS OF
ELECTRIC MOTORS

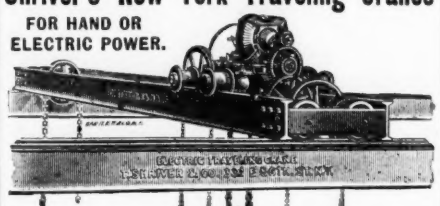
Specially adapted for driving Machine Tools, Cranes, Elevators, Pumps, Presses, and other Machinery.



We also make
Portable Drills, Hand Drills, Boiler Shell Drills, Light Drill Presses.

Shriver's New York Traveling Cranes

FOR HAND OR ELECTRIC POWER.



T. Shriver & Co. 333 East 56th St., NEW YORK.
MANUFACTURERS OF
TRAVELING CRANES of 1½, 2, 3, 5 and 10 Tons capacity, to be operated by Hand, or **wholly** or **in part** by Electricity.

Norton Emery Wheel Co.

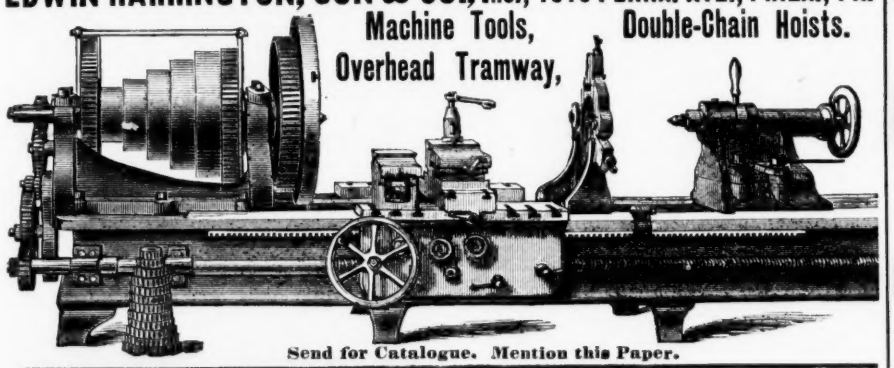
SEND FOR ILLUSTRATED CATALOGUE
Worcester, Mass.

CRANES, TROLLEYS, PORTABLE HOISTS, OVERHEAD TRACK.
SEND FOR CATALOGUE.

MARIS AND BEEKLEY, 2343 & 2345 Callowhill St., PHILADELPHIA, PA.

EDWIN HARRINGTON, SON & CO., Inc., 1515 PENNA. AVE., PHILA., PA.

Machine Tools, Overhead Tramway, Double-Chain Hoists.



Send for Catalogue. Mention this Paper.

IF YOU WANT ANYTHING IN THE LINE OF
DROP PRESSES · DROP HAMMERS · STAMPS OR AUTOMATIC DROP LIFTERS.
SEND FOR CATALOGUE TO
Miner & Peck Mfg. Co.
NEW HAVEN, CONN.
LARGEST LINE IN THE MARKET

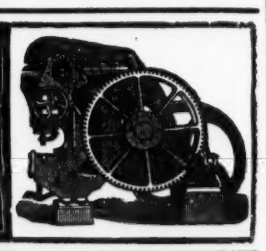
"The Mills of the Gods Grind Slowly,"
BUT NOT SO OF
OUR **Lathe Centre Grinder**
Just the Tool for You.
TRUMP BROS. MACH. CO., Mfrs.,
WILMINGTON, DEL.

American Standard Gauge & Tool Works,
WILMINGTON, DEL.
Makers of Implements for Standard Measurements.

Crescent Gauge. Flat Bar Gauge.
Send for New Pamphlet. JAS. A. TAYLOR & CO.

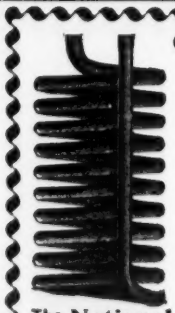
MACHINISTS' SCALES,
PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
COFFIN & LEIGHTON, SYRACUSE, N. Y.

PUNCHING AND SHEARING MACHINERY
AND BOILER MAKERS ROLLS.
NEW DOTY MANUFACTURING CO.
JANESVILLE WISCONSIN.



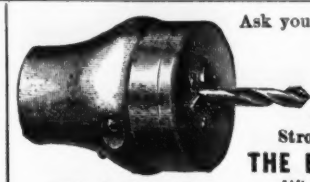
Dixon's Silica Graphite Paint

Will preserve a roof for TEN to FIFTEEN YEARS—perhaps longer, without repainting.
Unequaled for SMOKE STACKS, BOILER FRONTS, Etc.
Send for circulars on Paints and Painting.
JOS. DIXON CRUCIBLE CO., Jersey City, N. J.

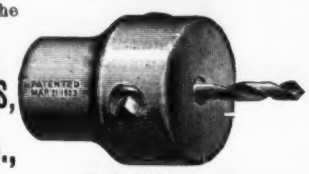


COILS and BENDS of IRON, BRASS, and COPPER PIPE of every description.
The National Pipe Bending Co.
52 River St., New Haven, Conn.

Ask your nearest Dealer, or send to the Manufacturers for



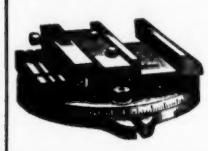
THE LATEST IMPROVED DRILL CHUCKS,



Strong, Accurate, Durable, Cheap.
THE E. HORTON & SON CO.,
Style A, Three-Jaw. Windsor Locks, Conn., U. S. A. Style B, Two-Jaw.
Or CHAS. CHURCHILL & CO., Ltd., 21 Cross St., Finsbury, London, Eng. Awards at the World's Fair.

"CUSHMAN" CHUCKS.

For Lathes, Drills, Chucking and Screw Machines, and for Special work. . . . . .
SEND FOR CATALOGUE.
THE CUSHMAN CHUCK CO., HARTFORD, CONN.



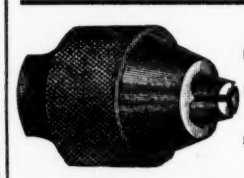
Jordan Planer Chucks.
For Price and Description, address
C. W. JORDAN
4 Wayne St.,
WORCESTER, MASS.

CHUCKS The "National."

INDEPENDENT, UNIVERSAL, or COMBINATION.
Est'd 1882. Strongest. Easiest to change. Best finish. Reversible Jaws (patented) giving 5 changes including every possible position. ILLUSTRATED CATALOGUE sent. Liberal discounts. Prompt shipment. W. WHITLOCK, 89 Cortlandt St., N. Y.—Works, Hoboken, N. J.

WE LEAD, OTHERS FOLLOW.

Sweetland Combination Chuck.
Reversible Jaws. Accurate, Standard Independent, Solid Shell, Solid Reversible Jaws, Strong and True.
SEND FOR CATALOGUE.
The HOGGSON & PETTIS MFG. CO., - New Haven, Conn.



Almond Drill Chuck.
Sold at all Machinists' Supply Stores.
T. R. ALMOND,
83 & 85 Washington St.,
BROOKLYN, N. Y.

Cranes

CUPOLAS, LADLES, TRUCKS.
Whiting Foundry Equipment Co.,
225 DEARBORN ST., CHICAGO | HARVEY, ILL.
NEW YORK OFFICE, 182 FRONT ST.

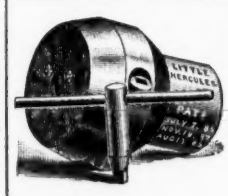
EVERY MACHINIST SHOULD HAVE A COPY OF
OUR CATALOGUE.
It is a 704 page cloth bound book. A copy will be sent, express paid, to any one sending $1.00, and the money paid for book will be refunded with first order amounting to $10.00 or over.
MONTGOMERY & CO.,
105 FULTON STREET,
NEW YORK CITY.

PEQUOT DRILL CHUCK.

A new Drill Chuck having a more powerful grip than any chuck ever offered. This seems a broad claim, but we prove it to mechanics who will examine. Ask at your dealers or write us for particulars.
THE D. E. WHITON MACHINE CO.,
5 Oak Street, New London, Conn., U. S. A.,
OR, SELIG, SONNENTHAL & CO.,
85 Queen Victoria St., London, E. C., England.

SKINNER CHUCKS.
Independent and Universal Chucks, Combination Lathe Chucks with patent reversible jaws, Drill Chucks, Planer Chucks and Face Plate Jaws.
SKINNER CHUCK CO.,
SEND FOR CATALOGUE. New Britain, Conn.

Write The Pratt Chuck Co., Clayville, N. Y., U. S. A., for free illustrated catalogue of
POSITIVE DRIVING DRILL CHUCKS.
Will drive either straight or Taper Snank Drills, Reamers, Rose Bits, etc., of any size, without a possibility of their slipping.
FOREIGN AGENCIES:
Ph. Roux et Cie., 54 Boulevard du Temple, Paris, France; E. Sonnenthal, Jr., Neue Promenade No, 5, Berlin, Germany; Selig, Sonnenthal & Co., 85 Queen Victoria St., London, E. C., England.



THE **Oneida Mfg. Chuck Co.**
ONEIDA, N. Y., U. S. A.
Manufacturers of The Monarch Lathe Chuck and Little Hercules Drill Chuck. Write for catalogue direct, or to
CHAS. CHURCHILL & CO., Ltd., 21 Cross Street, Finsbury, London, ENGLAND.

Special Screws and Studs in Brass or Steel.
Gear Cutting, Sheet Metal Stamping, Automatic Machinery built to order. Send sample or drawing for estimate.
SITTMANN & PITT,
353 ADAMS ST., BROOKLYN, N. Y.

SOFT CASTINGS,

Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.
THE BURR & HOUSTON CO.,
33 TO 39 FRANKLIN ST., BROOKLYN, N. Y.

"PRACTICAL DRAWING."

By J. G. A. MEYER.

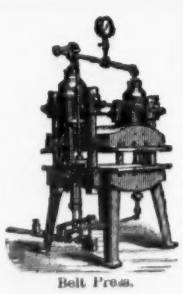
The demand for back numbers of the **American Machinist**, containing this valuable series of articles, has been so great, that, notwithstanding it has compelled us to issue special reprints of several of the articles, our stock is now limited to complete sets, with the exception of two or three issues, and orders can hereafter be filled **by the set only.**

A number of engineering schools are using these articles in lieu of a text book on this important branch of mechanics.

The set of 92 papers will be sent by mail to any address in the U.S., Canada or Mexico for $5.00, postpaid, and to any foreign country for $7.00.

Order now before our stock of papers is exhausted.

ADDRESS:
American Machinist,
203 BROADWAY,
NEW YORK.



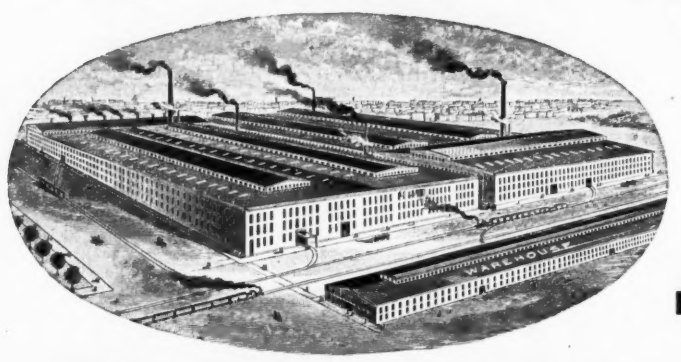
Belt Press.

HYDRAULIC MACHINERY,

PRESSES, PUMPS, PUNCHES, JACKS,
VALVES, FITTINGS, PACKINGS, ACCUMULATORS.
SEND FOR CATALOGUE D.
THE W. & S. HYDRAULIC MACHINERY WORKS,
WATSON & STILLMAN, Proprietors,
204, 206, 208 and 210 East 43d Street,
NEW YORK.

Forging Press

THE LODGE & DAVIS MACHINE TOOL CO.,



Works, Cincinnati, O., U. S. A.

DESIGNERS AND BUILDERS OF

MACHINE SHOP EQUIPMENTS,

including Standard Engine Lathes, Planers, Shapers, Radial and Upright Drills, Milling Machines, Screw Machines, Bolt Cutters, etc.

BRANCH HOUSES:

NEW YORK, 110 LIBERTY ST.
CHICAGO, 68-70 S. CANAL ST.
PHILADELPHIA, 19 N. SEVENTH ST.
BOSTON, 23-25 PURCHASE ST.
ST. LOUIS, 823 N. SECOND ST.
PITTSBURGH. WATER AND MARKET STS.

Lathes

OUR PAT. RADIAL DRILLS ARE BEST.

Good tools produce good work, we use only the finest machinery and employ the most skilled Mechanics, hence, are in position to offer the best Mechanisms to be obtained at a moderate price.

ENGINE LATHES.

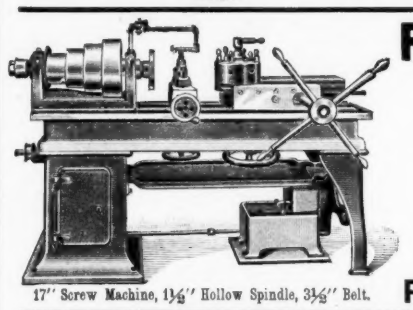
22" and 24" furnished in lengths of 8, 10, 12, 14, and 16 feet Bed.

With all modern Improvements.

Address,
Dietz, Schumacher & Co.,
Cincinnati, O., U. S. A.

DROP FORGINGS

WYMAN & GORDON
WORCESTER, MASS.



17" Screw Machine, 1¼" Hollow Spindle, 3½" Belt.

FLATHER & COMPANY,

NASHUA, N. H., U. S. A.

LATHES,

SCREW MACHINES,

PLANERS AND SHAPERS.

Engine
Turret
Motor-Gear
Double-Saddle
Pulley
Ghucking
Fox-Monitor
Brass-Working
Triple-Facing

LATHES

THE LODGE & SHIPLEY M. T. CO., Cincinnati, O., U. S. A.

TOOLS FOR SHEET METAL WORK,

Niagara

PRESSES, DIES, TINNERS' TOOLS, SHEARS,

NIAGARA STAMPING AND TOOL CO.,
BUFFALO, N. Y.

TWEDDELL'S HYDRAULIC MACHINE TOOLS.

TWEDDELL, PLATT & FIELDING'S "U. S." PATENTS.

For RIVETING, BENDING, FORGING, PUNCHING and SHEARING.

With Necessary PUMPS and ACCUMULATOR, Also Special Plant for Riveting Water Mains in Position.

Supplied in Great Britain to all H. M. Dockyards, The Fairfield Shipbuilding Company, J. & G. Thomson, Penn's, Maudslay's, and all the Railway Companies on the Continent—Krupp's, Gruson's, and all the German Dockyards and Railways, to Baldwin's, Altoona, Roanoke and Scranton Loco-shops, and the leading Shipbuilders and Bridge-builders throughout the world.

LICENSEES AND MANUFACTURERS:

FIELDING & PLATT, Gloucester, England.

Apply TWEDDELL'S SYSTEM, Limited,

14 Delahay Street, - Westminster, London, England.

Purchasers are Warned against Buying or Using Infringements of our Patents.

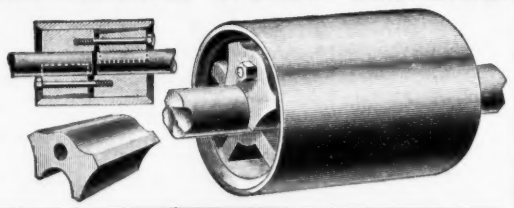
STUART'S PATENT COMPRESSION WEDGE COUPLING.

NO KEYS. KEY SEATING. SLIPPING.

CHEAPEST in MARKET, also the SIMPLEST and BEST.

SENT ON TRIAL.

Can be attached or removed in a few seconds without injury to shaft or coupling. Send for discount and illustrated Price List of 40 sizes.



R. J. STUART'S FOUNDRY AND MACHINE WORKS,
NEW HAMBURGH, N. Y.

THE PERFECT DRAWING TABLE

With Adjustable Parallel Ruler,
More Reliable Than The Old T-Square.

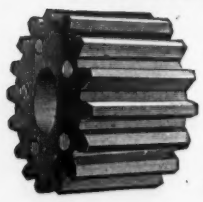
30x42 36x48 36x60
$30. $35. $40.

Henry J. Hughes,
360 45TH STREET,
BROOKLYN, N. Y.

STRANGE, BUT TRUE!!

THE NEW PROCESS RAW HIDE GEARS

ASTONISH THE MACHINERY WORLD.



They Outwear any Metal.

They require No Lubricant.

They are Noiseless and Clean.

NEW PROCESS RAW HIDE CO.,
PATENTEES AND SOLE MANUFACTURERS,
SYRACUSE, N. Y., U. S. A.

MARKING MACHINE,

For rolling trade-marks on flat or round Iron or Steel surfaces. Used by Cutlery, Pistol, Twist Drill, Wrench, and many other mfrs. 200 in use. Read up. Catalogue "B" free.

DWIGHT SLATE MACHINE CO.,
HARTFORD, CONN.

Stover Power Hack Saw and Friction Drills.

Saws made in two sizes Nos. 1 and 2. Cut 4½ to 8 inches. Send for circulars to

STOVER NOVELTY WORKS,
Mfgrs. of Wood and Iron-Working Machinery. Special Machinery to order
23 River St., FREEPORT, ILL., U. S. A.
C. W. BURTON, London, Eng.

P. BLAISDELL & CO.,
Manufacturers of
Machinists' Tools,
WORCESTER, MASS.

SEND FOR CATALOGUE.

WORCESTER MACHINE SCREW CO.

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

Do you make Shrink or Force Fits?

We have an Inside Micrometer Caliper that is just the tool for this purpose. Its price is only $1.75

We have another (price $6.00) that will actually measure a hole or length in inches and fractions thereof from 2½" to 13" by thousandths.

WRITE FOR CIRCULARS.

J. T. SLOCOMB & CO., Providence, R. I.

ENGINEERS' MANUAL containing valuable tables, rules, etc. 194 pages, cloth, 50c. 125 page catalogue 10c.
AMERICAN INDUSTRIAL PUB. CO., Bridgeport, Conn.

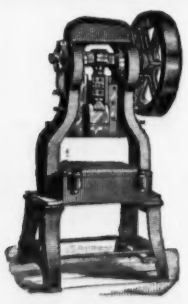
POWER PRESSES

ADJUSTABLE. IMPROVED.

FOR TIN, BRASS AND SHEET IRON WORKERS.

Workmanship Guaranteed. Strong and Durable.

Send for Circulars.



OUR AGENTS: J. J. McCABE, New York. DAWSON & GOODWIN, Chicago. A. B. BOWMAN, St. Louis. C. & F. MACHINE TOOL CO., Boston. THOS. K. CAREY & BROS. CO., Baltimore. CHAS. A. STRELINGER & CO., Detroit.

Prices and Circulars furnished by above on 12 in., 15 in. and 20 in. Crank Shapers, 26 in. Belt Shaper, Hand Fox and Cab. Turret Lathes, Power Presses, made by

THE SPRINGFIELD MACHINE TOOL CO., Springfield, Ohio.

LANDIS BROS., WAYNESBORO, PA.,

MANUFACTURERS OF

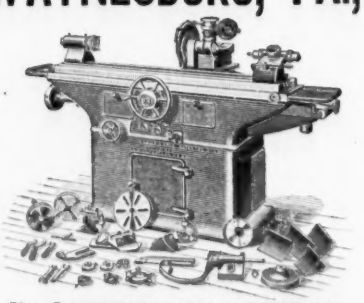
Universal and Plain Grinding Machines.

Any speed between maximum and minimum of work and traverse of wheel acquired in an instant. Provided for free use of water in all grinding operations. For convenience unequalled. Fully guaranteed.

SEND FOR CATALOGUE.

England: Chas. Churchill & Co., 21 Cross St., Finsbury, London, E. C.

France and Belgium: Ad'Janssens, 16 Place de la Republique, Paris.



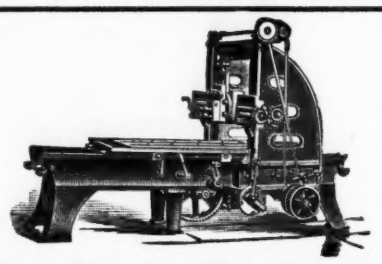
No. 3 UNIVERSAL GRINDER.

MORSE TWIST DRILL AND MACHINE COMPANY,

Manufacturers of Morse Patent Straight-Lip Increase Twist Drills. New Bedford, MASS.

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

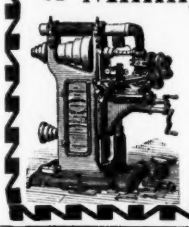
F. E. REED CO.,
Worcester, Mass.,
MANUFACTURE
ENGINE LATHES
HAND LATHES, FOOT LATHES AND MILLING MACHINES.
Manning, Maxwell & Moore,
Selling Agents, 111 Liberty St., New York.
60 South Canal St., Chicago.



New Haven Manf'g Co.,
NEW HAVEN, CONN.
IRON-WORKING MACHINERY.

W. C. YOUNG MFG. CO., WORCESTER, MASS.
Foot Lathes, Engine Lathes,
SHEARS AND PUNCHES.

A Milling Machine or . . . .

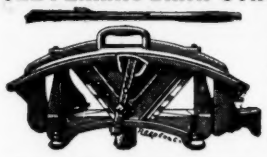


a Cutter and Tool Grinder.

If you need either, and where is the shop that doesn't? write
The Cincinnati Milling Machine Co.,
Cincinnati, Ohio.

NEW LINE OF ENGINE LATHES.
DRAPER MACHINE TOOL CO.
SUCCESSOR TO LATHE & MORSE TOOL CO.
WORCESTER, MASS., U. S. A.

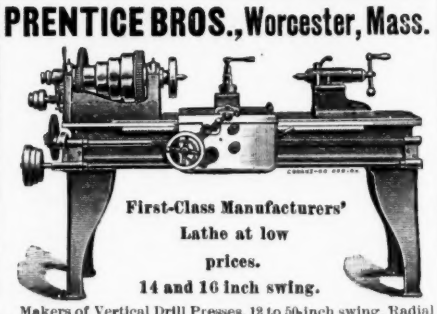
THE PERKINS DRAW STROKE TRIMMER,



An Indispensable Tool for all Bench Woodworkers. Latest and Best Design. Infringers Prosecuted. Trial, not orders, solicited.
PERKINS & CO.,
Grand Rapids, Mich.
STOCKS, NEAVE & CO.,
Manchester, England.

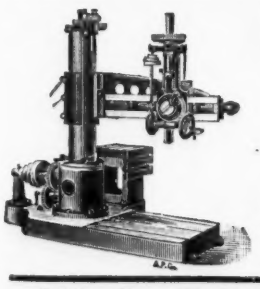
CUTTING-OFF MACHINES.
HURLBUT-ROGERS MACHINE CO.,
SO. SUDBURY, MASS.

PRENTICE BROS., Worcester, Mass.



First-Class Manufacturers' Lathe at low prices.
14 and 16 inch swing.

Makers of Vertical Drill Presses, 12 to 50-inch swing, Radial Drills, Gang Drills, Boiler Makers' Drills, Radial Drilling and Countersinking Machines, for ship plate and bridge work. Special Drilling Machinery.
Engine Lathes from 11 to 21-inch swing, any length of bed with single or double back-geared heads and any style of rest, with or without taper attachment. SEND FOR CATALOGUE.
FOREIGN AGENTS:
CHAS. CHURCHILL & CO., L't'd, London, Eng.
SCHUCHARDT & SCHUTTE, 59-61 Spandauerstrasse, Berlin, Germany.
ADPHE JANSSENS, 16 Place de la Republique, Paris, France.



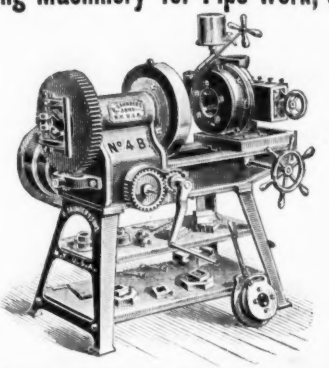
Radial Drills . . .

Most improved tools manufactured to-day. Special features found only on our make.
It pays to know everything about them. Write to
BICKFORD DRILL AND TOOL CO.
3 Pike Street, Cincinnati, Ohio.

Albro Worm and Worm Gear

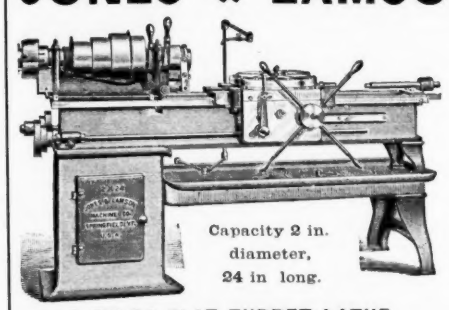
Consumes less power and gives better results than any other System. Information cheerfully furnished.
The Albro-Clem Elevator Co.,
411 & 413 Cherry St.,
Philadelphia, Pa.

D. SAUNDERS' SONS,
MANUFACTURERS OF
PIPE CUTTING AND THREADING MACHINES,
Steam and Gasfitters' Hand Tools,
Tapping Machinery for Pipe Work, etc.



The No. 4 B Machine for Cutting and Threading Pipe ⅛ in. to 4 in., by HAND or POWER.
SEND FOR CATALOGUE TO
21 Atherton St., YONKERS, N. Y.

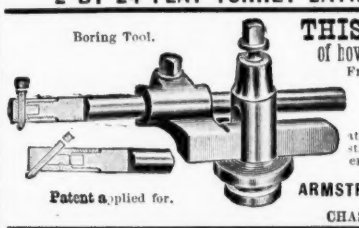
JONES & LAMSON MACHINE CO.,
SPRINGFIELD, VERMONT.



Capacity 2 in. diameter, 24 in long.
2 BY 24 FLAT TURRET LATHE.

Sole builders of the Flat Turret Lathe, also builders of other Turret Machinery. Publishers of "Rapid Lathe Work," by new method (Hartness System). Send for catalogue.

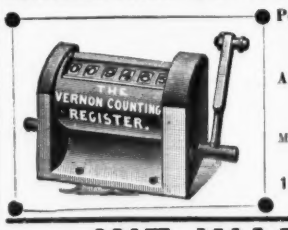
THIS WILL GIVE YOU AN IDEA
of how these tools gain in favor after being once tried.



From WOONSOCKET MACHINE AND PRESS CO., WOONSOCKET, R. I., May 21st, 1894.
Please send us for trial one No 2 Tool Holder. June 26th, 1894.
Sample Tool very satisfactory. Please send us at once: 41 Armstrong Tool Holders No. 1. 26 Armstrong Tool Holders No. 2 17 Armstrong Tool Holders No. 3. 6 Armstrong Tool Holders No 5
For circulars, prices, etc, send to
ARMSTRONG BROS. TOOL CO., 76 Edgewood Ave., Chicago.
Or to your nearest first-class dealer.
CHAS. CHURCHILL & CO., Ltd., London, Eng., Agents.

Cable Address,
"TRIMMER"
CATALOGUE FREE.
AMERICAN MACH'Y CO.,
DETROIT, MICH., U. S. A.
Branch, No. 11 Old Hall St., Liverpool, Eng.

THE VERNON
Revolution Counters, Car Fare Registers, &c.



Positive Motion.
Steel Gearing.
Brass Wheels.
Absolutely Accurate.
S. M. BALZER,
Manufacturer of Counting and Measuring Machines.
129 Worth Street NEW YORK.

WE WANT
Dealers throughout the country to handle our sensitive drills.
D'AMOUR & LITTLEDALE, 204 E. 43d St., New York

MECHANICS

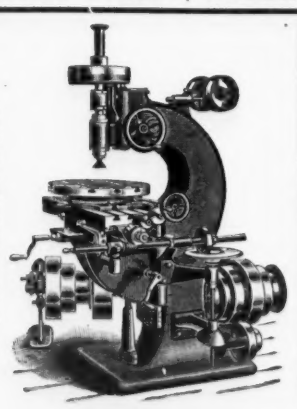
DIPLOMAS AWARDED. Courses in other trades, all including thorough instruction in Mathematics and Physics. Send for FREE circular, stating subject you wish to study to
THE
Correspondence School of Mechanics
SCRANTON, PA.

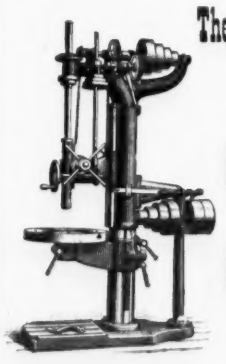
W. D. FORBES & CO.,
ENGINEERS,
1300 HUDSON STREET, HOBOKEN, N. J.

BINDING POSTS, CONTACT BUTTONS AND ALL ELECTRICAL MACHINE WORK.
(TWO BLOCKS FROM 14TH ST. FERRY.)

FINE MACHINE WORK,
LIGHT FORGING,
DRAUGHTING AND DESIGNING.

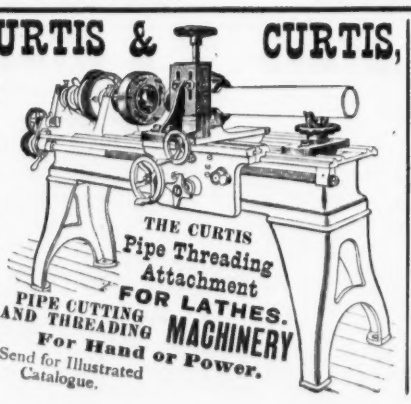
THE BECKER MILLER No. 4
MANUFACTURED BY
JOHN BECKER MANUFACTURING CO.,
FITCHBURG, MASS.





The Aurora Tool Works,
AURORA, IND.
BUILDERS OF
UPRIGHT AND RADIAL DRILLS.

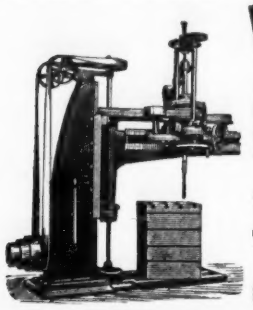
CURTIS & CURTIS,
66 Garden St., Bridgeport, Ct.



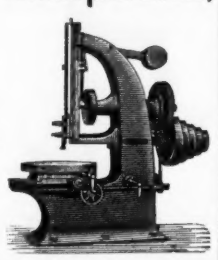
Send for Illustrated Catalogue.

BARNES' UPRIGHT DRILLS

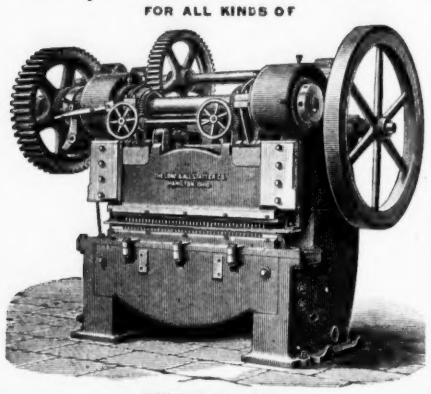
Complete line, ranging from our New Friction Disk Drill, for light work, to 42-inch Back Geared Self Feed Drill.
Send for Catalogue and Prices.
W. F. & JOHN BARNES CO.,
1995 Ruby St., Rockford, Ill.
ENGLISH AGENTS,
CHAS. CHURCHILL & CO., LTD.,
21 CROSS ST., FINSBURY. LONDON, E.C., ENG.



WM. SELLERS & CO., Incorporated,
PHILADELPHIA, PA.
MANUFACTURERS OF
MACHINE TOOLS,
TRAVELING CRANES AND SWING CRANES,
Operated by Electricity, Shafts or Independent Engines.
Turn Tables, Testing Machines, Shafting, Pulleys, Hangers, Couplings, Etc.
INJECTORS FOR ALL CLASSES OF BOILERS.



The LONG & ALLSTATTER CO.,
HAMILTON, OHIO,
Multiple Punches and Gate Shears
FOR ALL KINDS OF



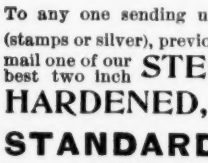
MULTIPLE PUNCH.
BOILER, TANK AND STRUCTURAL IRON WORK, ROLLING MILLS, LOCOMOTIVE SHOPS, CAR AND WAGON WORKS, PLOW SHOPS, &c., &c.

STARRETT'S FINE
TOOLS

Skilled mechanics prefer them. Live dealers sell them. Send for Catalogue. . . . . .
L. S. Starrett
ATHOL, MASS., U. S. A.

TELESCOPES SEND FOR CATALOGUE
W. & D. MOGEY,
45TH ST. BAYONNE N.J.

DETRICK & HARVEY MACHINE CO.,
BALTIMORE, MD.
MANUFACTURERS OF THE
ADAMS
Automatic Bolt-Threading and Nut-Tapping Machine,
Made in all Sizes to Cut from 1-4" to 6".



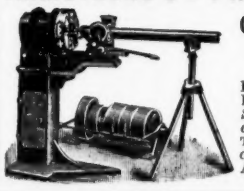
The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list.

Manufacturers of The Open Side Iron Planer.

CATCH ON NOW.
You'll never get another chance.
To any one sending us **TEN CENTS** (stamps or silver), previous to October 1st, we will mail one of our best two inch **STEEL RULES** with ends **HARDENED,** Only one rule to the same address.
STANDARD TOOL CO.,
ATHOL, MASS., U. S. A.
MANUFACTURERS OF
MECHANICS FINE TOOLS.

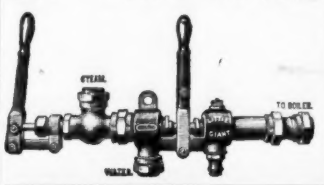
CHAS. A. STRELINGER & CO.,
Tools, Supplies and Machinery
DETROIT, MICH.

ARMSTRONG'S PIPE THREADING
—AND—
Cutting-off Machines



Both Hand and Power. Sizes 1 to 6 inches. Water, Gas, and Steam Fitters' Tools, Hinged Pipe Vises, Pipe Cutters. *Stocks and Dies universally acknowledged to be* THE BEST. *Send for catalog.*
Armstrong Mfg. Co., Bridgeport, Conn.

DO YOU WANT TO GET ACQUAINTED

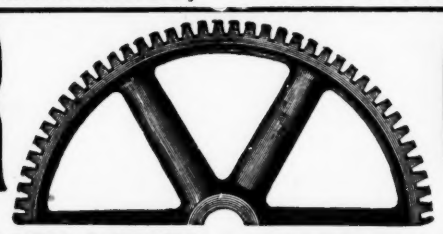


with the best Lifting Locomotive Injector made? If so, send for
Catalogue of RUE'S "LITTLE GIANT."
It contains also much useful information on the subject of Injectors in general, such, as we think, will be of interest to every Engineer or Fireman, as well as to Mechanics and Engineers generally.
RUE MFG. CO., 118 North 9th St., Phila., Pa.

AUTO MATIC
PENBERTHY
INJECTOR
PENBERTHY INJECTOR CO. MF'R'S, DETROIT, MICH.

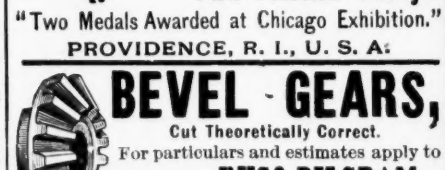
BACK VOLUMES OF THE AMERICAN MACHINIST
For any of the fourteen years, 1880 to 1893, inclusive, may still be obtained, but must be ordered soon, as our stock is nearly exhausted. Price, unbound, $3.00 per volume postpaid. Bound in cloth, $4.00 per volume (purchaser paying freight or express charges). No separate back numbers prior to 1893 are now carried in stock. Only complete volumes furnished prior to 1893.
AMERICAN MACHINIST, 203 Broadway, New York.

GEARS CUTTING



LELAND, FAULCONER & NORTON CO. Detroit, Mich.

VOLNEY W. MASON & CO.,
MANUFACTURERS OF
NEW PAT. WHIP HOIST,



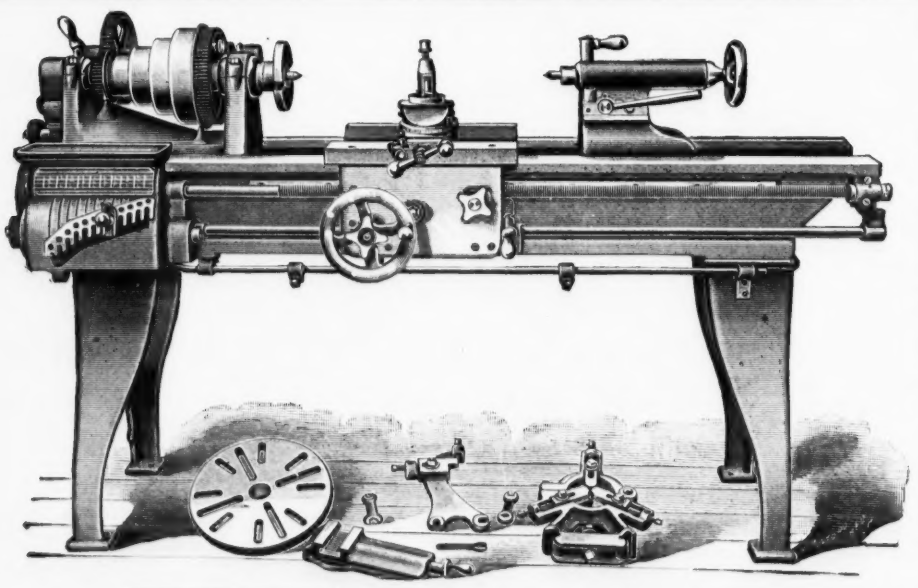
Pat. Friction Pulleys.
"Two Medals Awarded at Chicago Exhibition."
PROVIDENCE, R. I., U. S. A.

BEVEL - GEARS,
Cut Theoretically Correct.
For particulars and estimates apply to
HUGO BILGRAM,
MACHINIST,
Successor to
BREHMER BROS.,
440 N. 12th St., Philadelphia, Pa.

UNIVERSAL LAMP HOLDER.
Place your lamp just where you want it.

Trade supplied. Salesmen wanted. Catalogue free.
FARIES MFG. CO., - - Decatur, Ill.

ROBERT POOLE & SON CO.
ENGINEERS & MACHINISTS.
TRANSMISSION MACHINERY
MACHINE MOULDED GEARING
SPECIAL FACILITIES FOR THE
HEAVIEST CLASS OF WORK
BALTIMORE, MD.



14 in. x 6 ft. Hendey-Norton Lathe with Improved Automatic Stop.

EUROPEAN AGENTS:
SCHUCHARDT & SCHUTTE, 59 Spandauerstrasse, Berlin.
CHAS. CHURCHILL & CO., L'd 21 Cross Street, Finsbury, London.
EUGEN SOLLER, Basel, Switzerland.

THIS Lathe COMBINES the LATEST and BEST Improvements. Automatic Stop. It is Simple, Durable, Indispensable. It will AUTOMATICALLY STOP the Carriage in EITHER direction. It is equally efficient whether FEEDING or THREAD-CUTTING. Running up to a shoulder, boring to BOTTOM of holes, or INTERNAL THREAD-CUTTING. No danger of spoiling either tool or work. It is a safeguard against accidents, in either direction.

Feeds—It has all feeds in daily use with simple movement of lever.

Threads—It has all threads in daily use with simple movement of lever.

Carriage—The Carriage reverses in Apron. No slamming of Countershaft. There is no Comparison between this Lathe and the old style or common lathe. Quick work, rapid changes, satisfactory results. Buy the best. Send for Circular.

THE HENDEY MACHINE CO.,
TORRINGTON, CONN.

THE BUCKEYE AUTOMATIC CUT-OFF ENGINES,

Slow Speed, Medium Speed and High Speed Engines.

Simple, Compound, and Triple Expansion Engines, High Pressure Boilers.

Complete Steam Power Plants of Highest Attainable Efficiency. Address

Buckeye Engine Co.
No. 26 Franklin Ave.,
SALEM, O.

ALBANY STEAM TRAP CO., ALBANY, N. Y.

RETURN STEAM TRAPS, SPECIAL **BOILER FEED PUMPS** AND PUMP GOVERNORS.

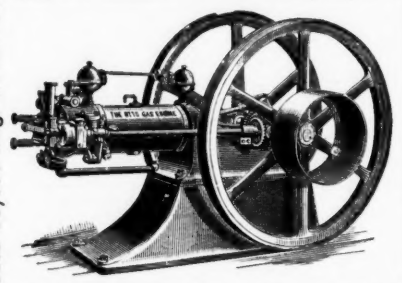
AUTOMATIC **STEAM PUMPS** AND GOVERNOR COMBINED FOR PUMPING HOT CONDENSED WATER.

Renewable Seat and Disc VALVES.

"OTTO" GAS ENGINE WORKS.

SCHLEICHER, SCHUMM & CO.,
33d and Walnut Sts., PHILADELPHIA.
Branch Office, 245 Lake St., CHICAGO.
New York Agency, 18 Vesey St., N. Y.

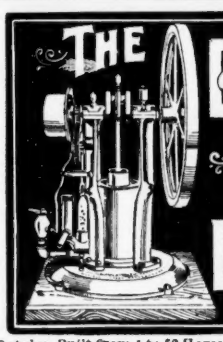
Over 35,000 Engines in Use



Guaranteed to consume 25 to 75 per cent. less Gas than any other Gas Engine doing the same work

---

THE BACKUS GAS ENGINE



2 styles, Built from 1 to 50 Horse Power. Send for Circular.
BACKUS WATER MOTOR CO., Newark, N.J.
Also Mfrs. VENTILATING FANS.

MACHINERY

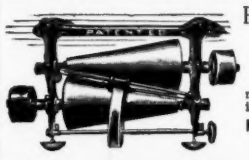
For Reducing and Pointing Wire.

ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.

For Machines or Information address the Manufacturer,

S. W. GOODYEAR, Waterbury, Conn.

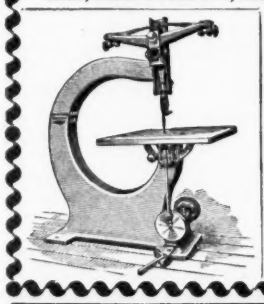
EVANS FRICTION CONE CO.



HANGING AND STANDING **CONES,**
MADE IN ALL SIZES.
Thousands in use transmitting from 1 to 50 H. P. For information address,
No. 85 WATER STREET, BOSTON, MASS.

J. A. FAY & CO.,

Offices, FRONT & JOHN STS., Cincinnati, O., U. S. A.



MAKERS OF **Wood-working Machinery** FOR ANY PURPOSE.

"Grand Prix" Paris.
Highest Awards Chicago.

PRINTED MATTER ON APPLICATION.

ENGINEERING COURSES FOR SPECIAL STUDENTS.

The Bromfield-Pearson Technical School, of Tufts College, offers exceptional opportunities to students who wish to pursue a two-years course in Engineering, or who may desire to fit for the Engineering Courses of the college in one year.

CARDNER C. ANTHONY, DEAN
TUFTS COLLEGE, MASS.

AT LAST! A SUCCESSFUL LOOSE PULLEY OILER.

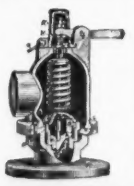
The only one. Saves annoyance. Saves labor.
KRIDLER MFG. CO.,
Agents Wanted. Grand Rapids, Mich.

LONERGAN'S SPECIALTIES

Oil Cups for all Purposes. Sight Feed Lubricators, Pop Safety Valves, Check Valves, Water Relief Valves, etc. "Clipper" Injectors, and other Steam Appliances.

J. E. LONERGAN & CO., 211 Race St., Phila., Pa.

CATALOGUE FREE ON APPLICATION.



STEEL CASTINGS

FROM 1 TO 40,000 POUNDS WEIGHT.

Of Open Hearth, Chester or Bessemer Steel.

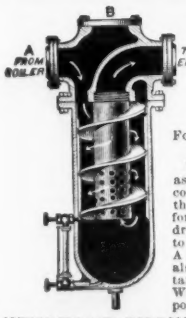
True to Pattern. Sound. Solid.

GEARING OF ALL KINDS, CRANK SHAFTS, KNUCKLES FOR CAR COUPLERS.

Cross Heads, Rockers, Piston-Heads, etc., for Locomotives. Steel Castings of Every Description.

CHESTER STEEL CASTINGS CO.,
Works, Chester, Pa. Office, 407 Library St., Philadelphia, Pa.

DRY STEAM.



Simpson's Centrifugal Steam Separator.

For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.

Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.

KEYSTONE ENGINE & MACHINE WORKS.
Fifth and Buttonwood Streets, Philadelphia.

MOFFET PORTABLE DRILL.

UNSURPASSED AS A **REAMER.**

Will work in any position.

Weighs 42 lbs. and drills from ¾ to 2 inches diameter.

Runs with Steam —OR— Compressed Air.

Send for Circular.

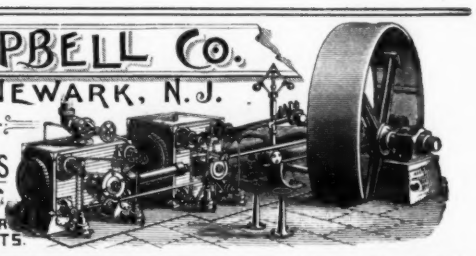
Manufactured by
J. G. TIMOLAT,
89 & 91 S. Fifth Ave., NEW YORK

THE WATTS, CAMPBELL CO.

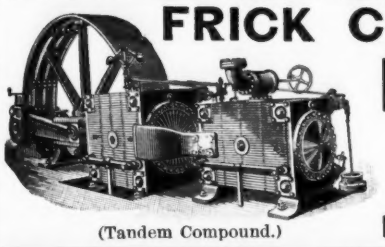
MANUFACTURERS OF IMPROVED **CORLISS STEAM ENGINES** IN FULL VARIETY.

CONTRACTS TAKEN FOR COMPLETE POWER PLANTS.

NEWARK, N. J.



FRICK COMPANY, WAYNESBORO, PA.



(Tandem Compound.)

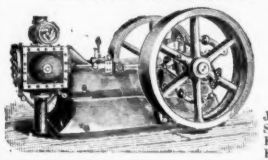
ECLIPSE CORLISS ENGINES,

40 TO 2,000 H. P., ALL STYLES.
Send for Illustrated Catalogue.

ALSO BUILDERS OF
Electric High Speed Engines and Ice-Making and Refrigerating Machinery.

WESTON ENGINES

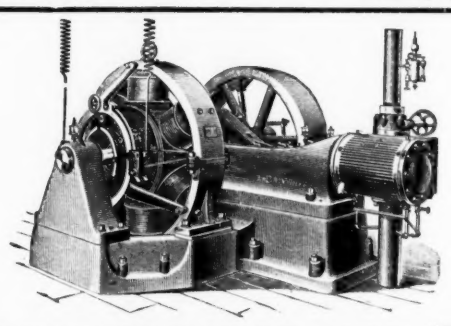
AUTOMATIC HIGH SPEED



HIGH PRESSURE BOILERS AND COMPLETE POWER PLANTS

WESTON ENGINE CO.,
PAINTED POST, N. Y.

REPRESENTATIVES.
Julian Scholl & Co., 126 Liberty St., N. Y. City.
Scranton Supply & Machinery Co., Scranton, Pa.
Hoffman-Russell Co. 82 Lake St., Chicago, Ill.
H. M. Sciple & Co., 3d & Arch Sts., Phila, Pa.



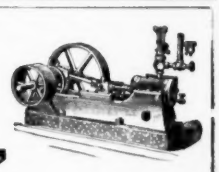
AMES IRON WORKS, OSWEGO, N.Y.

38 Cortlandt Street, New York City.
18 South Canal Street, Chicago, Ill.
50 Oliver Street Boston, Mass.
518 Arch Street Philadelphia, Pa.

ORR & SEMBOWER,

(INCORPORATED.)

VERTICAL, HORIZONTAL, MARINE —AND— **HOISTING ENGINES,**



VERTICAL AND HORIZONTAL BOILERS.
WRITE FOR CATALOGUE AND PRICES.
116 Liberty St., NEW YORK. Factory at READING, PA. 42 S. Clinton St., CHICAGO.

THE LANE & BODLEY CO., CINCINNATI, OHIO.

ENGINES,

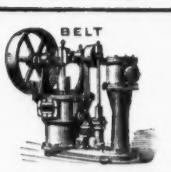
ALL SIZES.
Simple and Compound
CORLISS ENGINES A SPECIALTY
HEAVY SLIDE VALVE ENGINES,
Shafting, Hangers, Pulleys, Belt Elevators, etc.

STEAM

IN STOCK **CONOVER'S CONDENSERS**

HANDSOME CATALOGUE ON

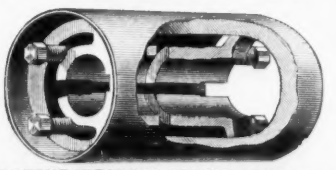
BELT



THE CONOVER MFG. CO. 39 CORTLANDT ST. N.Y.

GEO. V. CRESSON CO.,

Power Transmitting Machinery.



PATENT INTERNAL CLAMP COUPLING.

18th St. and Allegheny Ave., Philadelphia, Pa.
New York Office, - 136 Liberty Street.

CAN BE APPLIED AND REMOVED IN A FEW MINUTES. HAS A GRIP EQUAL TO A FORCING FIT.

A. & F. BROWN,

ENGINEERS, FOUNDERS & MACHINISTS.

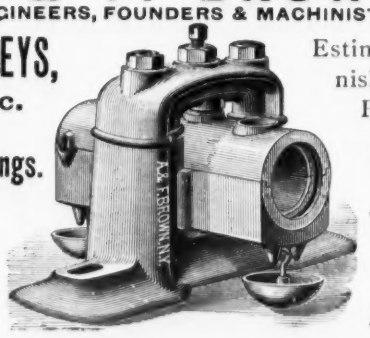
SHAFTING, PULLEYS, HANGERS, Etc.

Friction Clutch Couplings.

STEAM SIRENS, [WHISTLES].

Send for Catalogue.

17 Dey St., New York.



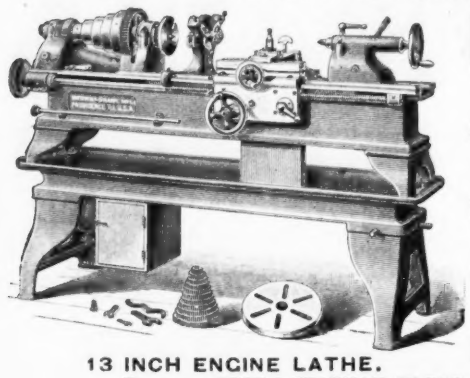
Estimates and Plans furnished for transmitting Power by

HORIZONTAL AND VERTICAL SHAFTING.

Also for Erecting same.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I.



13 INCH ENGINE LATHE.

MACHINES FOR TOOL ROOMS.

Universal Milling Machines.

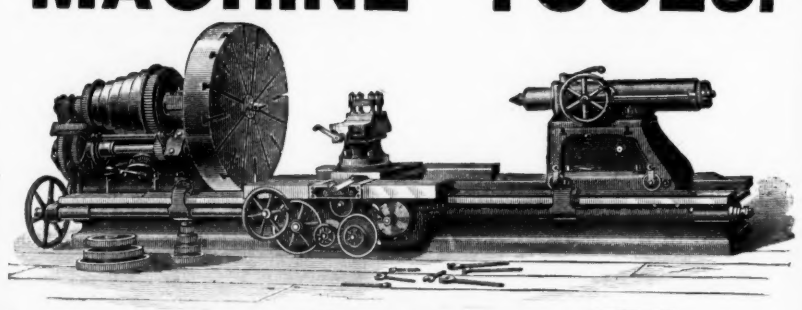
Universal Grinding Machines.

Universal Cutter and Reamer Grinders.

13 in. and 16 in. Engine Lathes.

ENGLAND—BUCK & HICKMAN, 280 Whitechapel Road London, E.
GERMANY—SCHUCHART & SCHUTTE, 59 Spandauerstrasse, Berlin, C. (Small Tools).
GERMANY—G. DIECHMANN, Ansbacherstr, 5 Berlin, W. 62.
FRANCE—FENWICK FRERES & CO., 21 Rue Martel, Paris.
FRANCE—F. G. KREUTZBERGER, 140 Rue de Neuilly Puteaux (Seine).
CHICAGO, ILL.—FRED. A. RICH, 23 South Canal St.
NEW YORK CITY—F. G. KRETSCHMER, 136 Liberty St., Room 503.

MACHINE TOOLS.



63-INCH FORGE LATHE.

THE NILES TOOL WORKS CO.,

HAMILTON, OHIO. Correspondence Solicited.

Jenkins' Packing Is all right, so say thousands of Engineers. We have positively refused many times to cheapen the quality to compete with other makers. It is better to day than when first put on the market 30 years ago. It is cheaper than many other kinds because it does not weigh as much per yard. It is honestly made, and will do all that any other Packing will do and has advantages that no other has.

NEW YORK. CHICAGO. JENKINS BROS. PHILADELPHIA. BOSTON.

BEMENT, MILES & CO., PHILADELPHIA, PA.

MANUFACTURERS OF

METAL WORKING MACHINE TOOLS

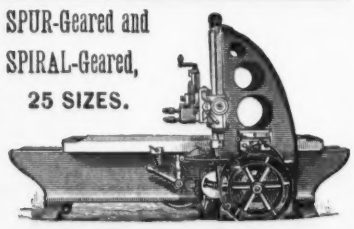
For RAILROAD SHOPS, LOCOMOTIVE AND CAR BUILDERS, MACHINE SHOPS, ROLLING MILLS, STEAM FORGES, SHIP YARDS, BOILER SHOPS, BRIDGE WORKS, ETC., ETC.

STEAM HAMMERS,

STEAM and HYDRAULIC RIVETING MACHINES.

PLANERS

SPUR-Geared and SPIRAL-Geared, 25 SIZES.



MANUFACTURED BY
The G. A. GRAY CO.,
477-483 SYCAMORE ST., CINCINNATI, O.
NEW YORK STORE, 121 LIBERTY STREET.

THE CARVIN MACHINE CO.,

Manufacturers of and Dealers in

MACHINE TOOLS.

LATHES, PLANERS, SHAPERS, DRILLS, MILLING MACHINES, TURRET LATHES, GEAR CUTTERS, CUTTER GRINDERS, TAPPING MACHINES, WIRE COILING MACHINES, POWER PRESSES, HAND LATHES, PROFILERS, &C., &C.

Write for New Catalogue and List of New and Second-Hand Tools for immediate delivery.

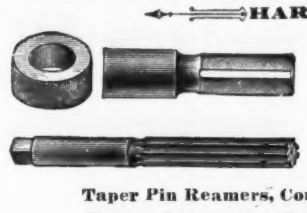
NEW No. 3 SCREW MACHINE,
Geared Friction Head and Power Feed.
4 OTHER SIZES AND 68 VARIETIES.

LAIGHT and CANAL STS., New York City, N. Y., also 51 NORTH 7th ST., Philadelphia, Pa.

THE PRATT & WHITNEY CO.

HARTFORD, CONN., U. S. A.

MANUFACTURE STANDARD SIZE



Cylindrical and Caliper Gauges,

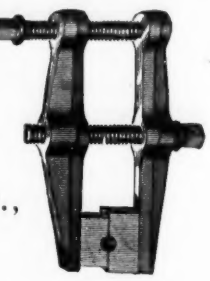
Straight and Taper Solid Hand Reamers, Chucking and Shell Reamers, Arbors and Steel Mandrels. Locomotive Taper and Taper Pin Reamers, Combination Lathe Chuck, Milling Cutters.

PRICE LIST AND DISCOUNT SHEET SENT UPON APPLICATION.
New York Warerooms: 136-138 LIBERTY STREET.
Western Branch: 98 WASHINGTON STREET, CHICAGO, ILL.

C AND MACHINISTS' CLAMPS.

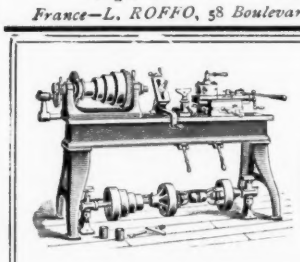
C Clamps, in 5 Sizes, with Openings 1¼, 2¼, 3¼, 4½, 6½ *inches.*

Machinists' Clamps, in 4 Sizes, with Openings 1¼, 2¼, 3¼, 4¼ *inches.*



The Billings & Spencer Co.,
Hartford, Conn., U. S. A.
Chicago Office: 17 S. CANAL STREET.

England—CHARLES CHURCHILL & CO., 23 Cross St., Finsbury, London, E. C.
France—L. ROFFO, 58 Boulevarde Richard Lenoir, Paris. *Russia—J. BLOCK, Moscow.*



WARNER & SWASEY,

CLEVELAND, OHIO.

MANUFACTURERS OF

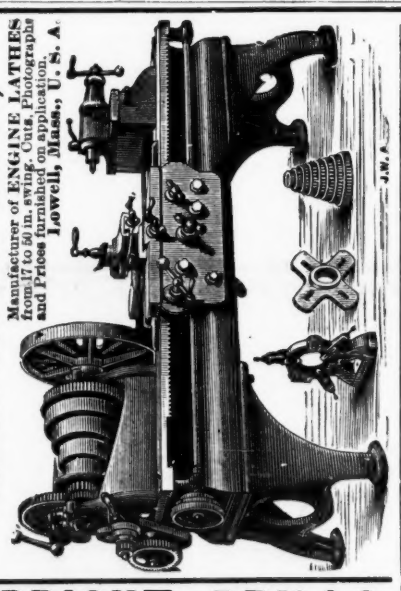
UNIVERSAL MONITORS.

IRON AND BRASS WORKING MACHINERY.

SEND FOR ILLUSTRATED CATALOGUE.

GEO. W. FIELD,

Manufacturer of ENGINE LATHES from 17 to 50 in. swing. Cuts, Photographs and Prices furnished on application.
Lowell, Mass., U. S. A.

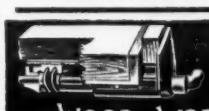


UPRIGHT DRILLS,

CUTTING-OFF MACHINES,
KEY-SEATING MACHINES
AND
SPECIAL MACHINERY.

Write for Catalogue and Prices.

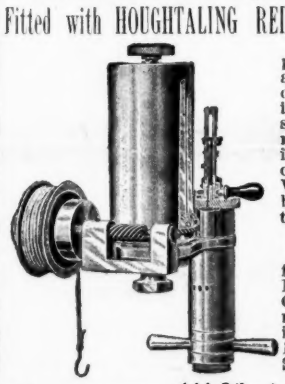
THE W. P. DAVIS MACHINE CO.,
ROCHESTER, N. Y.



WYMAN & GORDON
WORCESTER, MASS.
DROP FORGINGS
— WOOD WORKERS' VISES —

The Ashcroft Manufacturing Co.,

SOLE MANUFACTURERS OF
The Tabor Steam Engine Indicator,
Fitted with HOUGHTALING REDUCING MOTION.



The most Complete, Compact, and Reliable Indicator Outfit, for indicating high or slow speed engines now made. This instrument received at "The World's Columbian Exposition" the

Highest Award

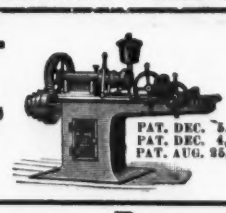
for Excellence of Design, Superior Grade of Workmanship and Finish, Reliability and Efficiency. Send for Special Pamphlet.

Office and Salesroom 111 Liberty St., New York.

J. M. ALLEN, PRESIDENT
WM. B. FRANKLIN, VICE-PRESIDENT.
F. B. ALLEN, SECOND VICE-PRESIDENT.
J. B. PIERCE, SECRETARY & TREASURER.

THE ACME MACHINERY CO.

CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single and Double Automatic
BOLT CUTTERS,
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.



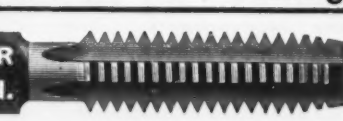
MACHINE TOOLS AT REDUCED PRICES.

In order to reduce our stock, we offer 16", 18", 21" and 24" engine lathes, 16", 22", 24" and 27" planers, 10", 12" and 15" speed lathes, 15" and 20" turret lathes, at a good discount from former prices.

We also have a few 16" and 18" second hand engine lathes, in good order, and of our own make.

THE HENDEY MACHINE CO., Torrington, Conn.

J. M. CARPENTER
PAWTUCKET, R. I.



Manufacturer —of— TAPS & DIES